PicoScope 6
PC Oscilloscope Software

User's Guide

psw.en-2.6
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1 Welcome

Welcome to PicoScope 6, the PC Oscilloscope software from Pico Technology Limited.

With a scope device from Pico Technology, PicoScope 10 turns your PC into a powerful PC Oscilloscope 10 with all the features and performance of a bench-top oscilloscope 9 at a fraction of the cost.

- How to use this manual 6
- What's new in this version? 2

Software version: PicoScope 6.0.10

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2 Version 6.0 update

PicoScope 6 is a major new release of PicoScope, Pico Technology's software for PC Oscilloscopes.

- Higher performance
  - Faster capture rates, making it easier to see fast-moving signals
  - Faster data processing
  - Better support for the latest PicoScope USB oscilloscopes including the PicoScope 5000 Series

- Improved usability and appearance
  - Clearer graphics and text
  - Tooltips and help messages to explain all features
  - Easy point-and-click tools for panning and zooming

- New features
  - The latest Windows .NET technology helps us get new features to you quicker
  - Custom probes 32 manager to make it easy for you to use your own probes and sensors with PicoScope
  - Multiple views of the same data, with individual zoom and pan settings for each view
  - Advanced triggering conditions 62
  - Properties sheet 15 displaying all settings at a glance

See the Release Notes 3 for more details.

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2.1 Release Notes

Release 6.0.10 - June 2007

- New channel scaling 51 feature
- Hysteresis added to advanced triggering
- New binary file formats 25 for exported data
- Logic trigger now has edge triggering.
- Full range of devices now available in Demonstration mode.
- New 200 second per division timebase added.

Release 6.0.9 - May 2007

- Improvements to advanced triggering.

Release 6.0.8 - May 2007

- New Advanced Triggering conditions 60
- Simplified Startup Settings menu 27

Release 6.0.7 - April 2007

- New Spectrum view 14
- New measurements to accompany spectrum view 14
- New Properties sheet 15
- New 'save & load defaults' 27 menu commands

Release 6.0.1 - December 2006

- New Auto Setup 53 button
- New support for PicoScope 5000 Series scopes
- Support for PicoScope 5000's large memory buffer, by storing waveform buffer 50 in scope memory
- Improved compatibility with PicoScope 5 PSD 22 files

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3 Introduction

PicoScope is a comprehensive software application for Pico Technology PC Oscilloscopes. Used with a scope device from Pico Technology, it creates a virtual oscilloscope, spectrum analyser and multimeter on your PC.

PicoScope 6 supports the following scope devices:

- PicoScope 5000 Series

PicoScope 6 runs on any 32-bit computer with Windows XP SP2 or Windows Vista. (See System requirements 7 for further recommendations.)

- Legal statement 5
- Contact information 6
- How to use this manual 6

How to use PicoScope 6

- Getting started: see using PicoScope for the first time 8, and PicoScope's Features. 9
- For further information: see descriptions of Menus 21 and Toolbars 49, and the Reference 75 section.
- For step-by-step tutorials, see the "How to 69" section.

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Fitness for purpose

No two applications are the same: Pico Technology cannot guarantee that its equipment or software is suitable for a given application. It is your responsibility, therefore, to ensure that the product is suitable for your application.

Mission-critical applications

This software is intended for use on a computer that may be running other software products. For this reason, one of the conditions of the licence is that it excludes usage in mission-critical applications, for example life-support systems.

Viruses

This software was continuously monitored for viruses during production, but you are responsible for virus-checking the software once it is installed.

Support

If you are dissatisfied with the performance of this software, please contact our technical support staff, who will try to fix the problem within a reasonable time. If you are still dissatisfied, please return the product and software to your supplier within 14 days of purchase for a full refund.

Upgrades

We provide upgrades, free of charge, from our web site at www.picotech.com. We reserve the right to charge for updates or replacements sent out on physical media.

Trademarks

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3.2 Contact information

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Sales email:	sales@picotech.com
Web site:	www.picotech.com

3.3 How to use this manual

If you are using a PDF viewer to read this manual, you can turn the pages of the manual as if it were a book, using the back and forward buttons in your viewer. These buttons should look something like this:

back

forward

You can also print the entire manual for reading away from your computer. Look for a print button similar to this:

print

For your first introduction to PicoScope, we suggest that you start with these topics:

- Using PicoScope for the first time 8
- Oscilloscope basics 9
- PCO basics 10
- PicoScope basics 10

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3.4 System requirements

To ensure that PicoScope operates correctly, you must have a computer with at least the minimum system requirements to run one of the supported operating systems, as shown in the following table. The performance of the oscilloscope will increase with more powerful PCs, including those with multi-core processors.

Item	Absolute minimum	Recommended minimum	Recommended full specification
Operating system	Windows XP SP2 Windows Vista		
Processor	As required by Windows	300 MHz	1 GHz
Memory		256 MB	512 MB
Free disk space (See note 1)		1 GB	2 GB
Ports	USB 1.1 compliant port	USB 2.0 compliant port	

Note 1: The PicoScope software does not use all the disk space specified in the table. The free space is required to make Windows run efficiently.

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4 Using PicoScope for the first time

We have designed PicoScope to be as easy as possible to use, even for newcomers to oscilloscopes. Once you have followed the introductory steps listed below, we hope that you will soon become a PicoScope expert.

1. Install the software. Load the CD-ROM that is included with your scope device, then click the "Install Software" link and follow the on-screen instructions.

2. Plug in your scope device. Windows will recognise it and make the necessary changes to allow your computer to work with it. Wait until Windows tells you that the device is ready to use.

3. Click the new PicoScope icon on your Windows desktop.

4. PicoScope will detect your scope device and configure itself, ready to display a waveform. The green Start 59 button will be highlighted to show that PicoScope is ready.

5. Connect a signal to one of the scope device's input channels and see your first waveform!

"Why did it do that?"

Help is at hand! Our technical support staff are always ready to answer your telephone call during office hours (see our Contact Details 6). At other times, you can contact our support forum or send us an email.

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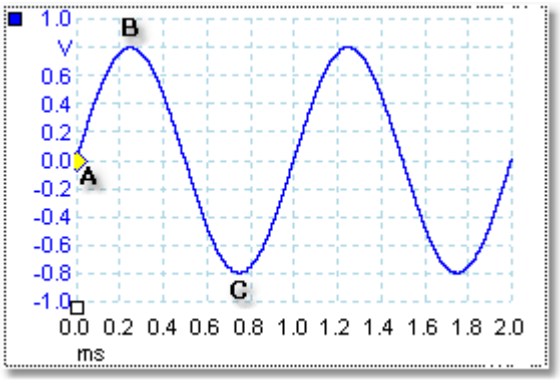
5 PicoScope and oscilloscope primer

This chapter explains the fundamental concepts that you will need to know before working with the PicoScope software. If you have used an oscilloscope before, then most of these ideas will be familiar to you. If not, please take a few minutes to read at least the "Oscilloscope basics" 9 and "PicoScope basics" 10 topics, and then return here to read the more detailed topics in this chapter when you need them.

5.1 Oscilloscope basics

An oscilloscope is a measuring instrument that displays a graph of voltage against time. For example, the picture below shows a typical display on an oscilloscope screen when a varying voltage is connected to one of its input channels.



Oscilloscope displays are always read from left to right. The blue line, called the "trace", begins at point A. If you look to the left of this point, you will see the number "0.0" on the voltage scale, and this tells you that the voltage is 0.0 volts. If you look below point A, you will see another number "0.0", this time on the time scale, which tells you that the time is 0.0 milliseconds (ms) at this point.

At point B, 0.25 milliseconds later, the voltage has risen to its positive peak of 0.8 volts. At point C, 0.75 milliseconds after the start, the voltage has dropped to its negative peak of -0.8 volts. After 1 millisecond, the voltage has risen back to 0.0 volts and a new cycle is about to begin. This type of signal is called a sine wave, and is one of a limitless range of signal types that you will encounter.

All oscilloscopes allow you to adjust the vertical and horizontal scales of the display. The vertical scale is called the voltage range (in this example at least, although scales in other units are possible). The horizontal scale is called the time base and is measured in seconds or, as in this example, fractions of a second.

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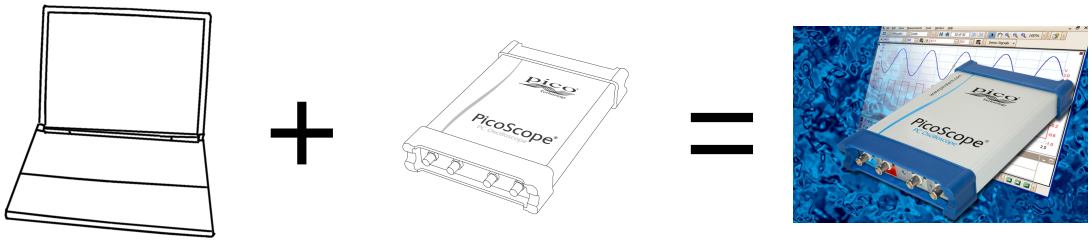
5.2 PCO basics

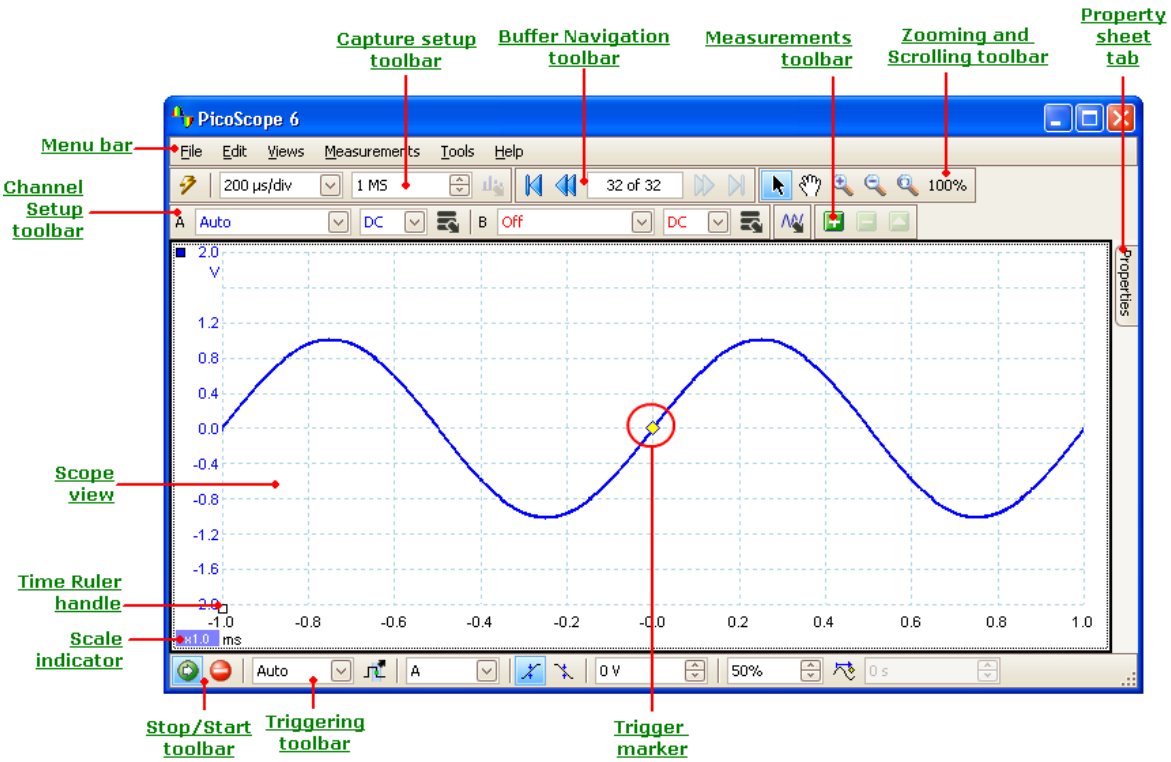
A PCO (PC Oscilloscope) is a virtual oscilloscope [9] that consists of a hardware scope device and a PC running oscilloscope software. Oscilloscopes were introduced long before digital computers existed, and were originally self-contained electronic instruments with limited abilities. Later oscilloscopes began to use new digital technology to introduce more functions, but they remained highly specialised and expensive instruments. PC Oscilloscopes are the latest step in the evolution of oscilloscopes, combining the measuring power of Pico Technology's scope devices with the convenience of the PC that's already on your desk.



PC scope device PCO

5.3 PicoScope basics

PicoScope can display simple waveforms such as the example we saw in the "Oscilloscope basics [9]" topic, but has many advanced features too. The screen shot below shows the PicoScope window. Click on any of the underlined labels to learn more. Also, please see "Windows, views and viewports" [19] for an explanation of these important concepts.



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5.4 Frequency legend

The frequency legend appears when you have placed two time rulers 17 on a scope view 13. It shows 1/Δ in hertz (the SI unit of frequency, equal to cycles per second), where Δ is the time difference between the two rulers. You can use this to estimate the frequency of a periodic waveform, but you will get more accurate results by creating a frequency measurement using the Add Measurements button on the Measurements toolbar 52.

5.5 Measurements table

A measurements table contains the automatic measurements that you have instructed PicoScope to make on a particular view. 13 You can add, delete or edit measurements from this table.

Name	Channel	Scope	Value
Frequency	A	Whole trace	1 kHz
AC RMS	A	Between rulers	565.3 mV

To add a measurement

Click the Add Measurement button on the measurements toolbar 52.

To delete a measurement

Select a measurement in the table by clicking once on it, and then click the Delete Measurement button on the measurements toolbar 52. If you delete the only measurement in the table, the table will be removed.

To edit a measurement

If the measurement you wish to edit is selected, click the Edit Measurement button on the measurements toolbar 52. Otherwise, double-click on the measurement.

To change the width of a measurement column

Drag the column's border to create the column width you need. The cursor will change to a column resize symbol as shown here.

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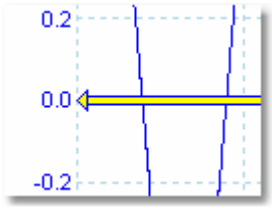
5.6 Post-trigger arrow

The post-trigger arrow is a modified form of the trigger marker 18 that appears temporarily while you are setting up a post-trigger delay, or dragging the trigger marker after setting up a post-trigger delay. (What is a post-trigger delay? 80)

The left-hand end of the arrow indicates the trigger point, and is aligned with zero on the time axis. If zero on the time axis is outside the scope view, 13 then the left-hand end of the post-trigger arrow appears like this:

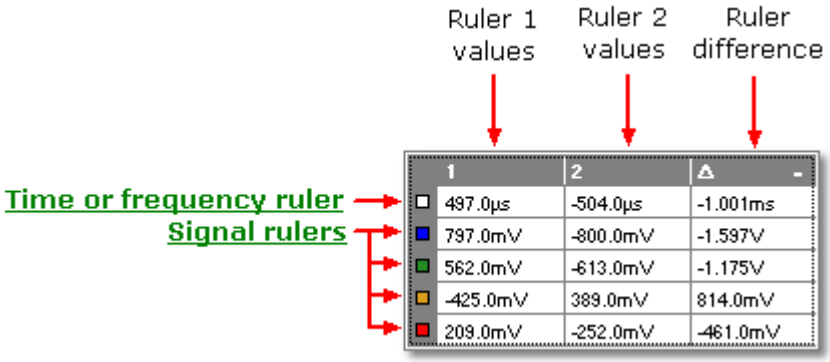


The right-hand end of the arrow (temporarily replacing the trigger marker 18) indicates the trigger reference point.

Use the buttons on the Triggering toolbar 60 to set up a post-trigger delay.

5.7 Ruler legend

The ruler legend displays the positions of all the rulers 82 you have placed on the view. 82 It appears automatically whenever there is a ruler on the screen.



For a reminder of which row refers to which signal, point using the mouse to one of the colour-coded boxes in the left-hand margin and a label will appear, like this: Channel A.

You can drag the legend around the view, resize it by dragging one of its edges, or minimise it by clicking the minimise button - in the top right-hand corner.

See also: frequency legend 11 (which shows 1/Δ, where Δ is the time difference).

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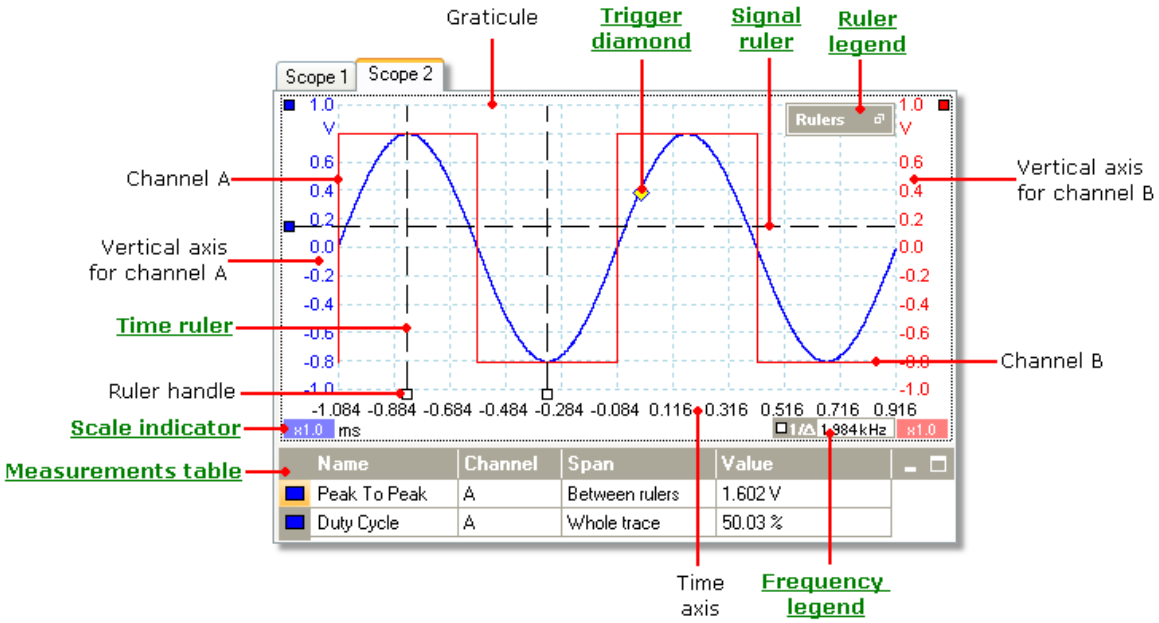
5.8 Scope view

A scope view shows the data captured from the scope as a graph of signal amplitude against time. PicoScope opens with a single view, but you can add more views by using the views menu 29. Similar to the screen of a conventional oscilloscope, a scope view shows you one or more waveforms with a common horizontal time axis, with signal level shown on one or more vertical axes. Each view can have as many waveforms as the scope device has channels. Click on one of the labels below to learn more about a feature.



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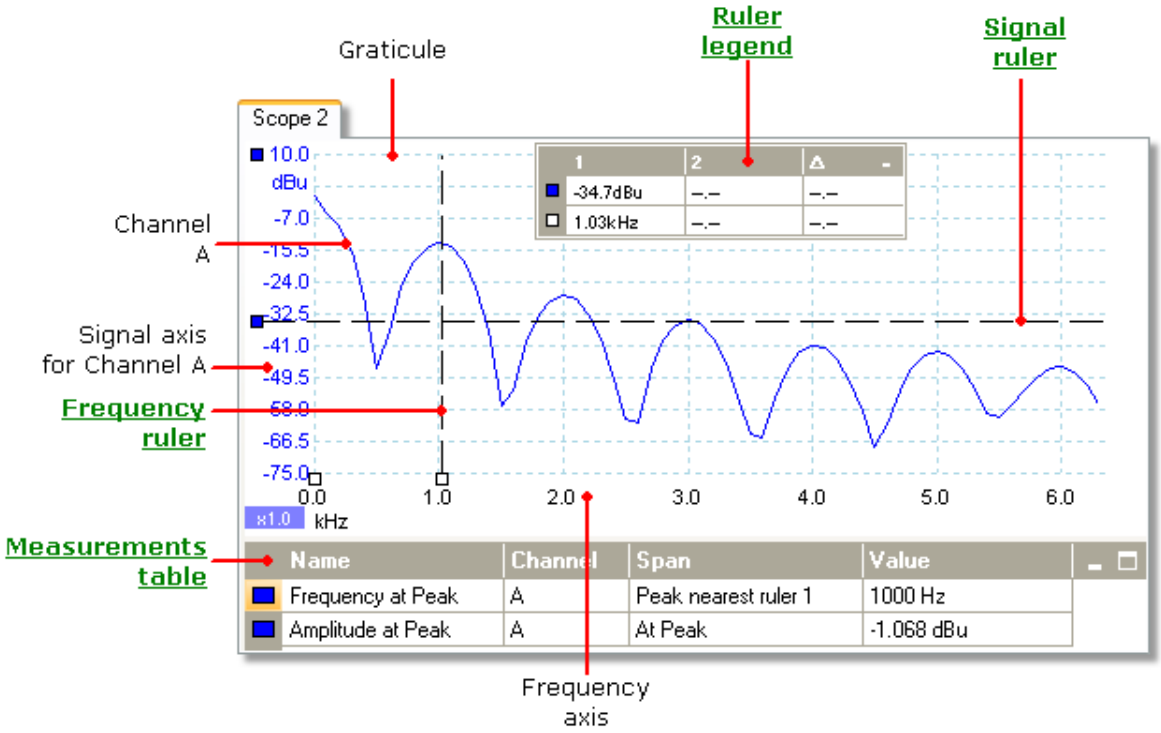
5.9 Spectrum view

A spectrum view is one view of the data from a scope device. PicoScope opens with a single view, but you can add more views by using the views menu 29. Similar to the screen of a conventional spectrum analyser, a spectrum view shows you one or more spectra with a common frequency axis. A spectrum is a diagram of signal level on a vertical axis plotted against frequency on the horizontal axis. Each view can have as many spectra as the scope device has channels. Click on one of the labels below to learn more about a feature.



For more information, see: How to set up the spectrum view 74 and Spectrum Options dialog. 54

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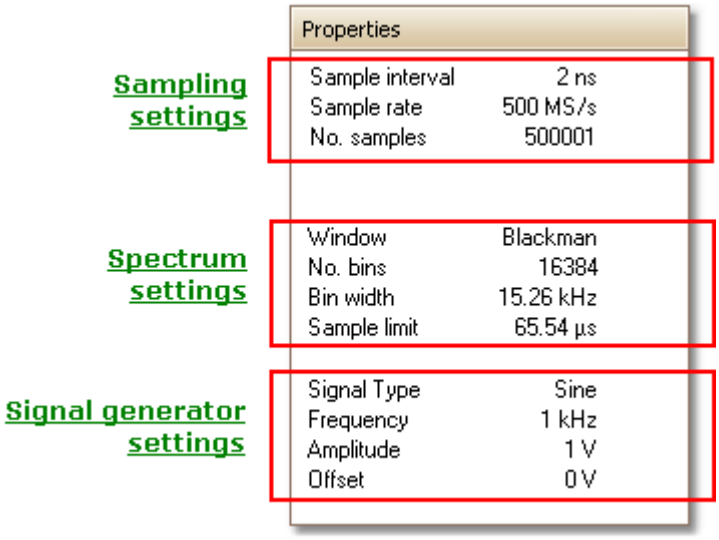
5.10 Properties sheet

The Properties sheet is a summary of the settings that PicoScope 6 is using. It normally appears to the right of the waveforms in the PicoScope window, but you can move it if you wish.



Positioning the Properties sheet

The Properties sheet has a number of modes. When you first start PicoScope 6, it is in "hidden" mode.

- Hidden. All you can see is a tab labelled Properties at the right-hand edge of the window.
- Quick view. To use "quick view", move the pointer over the tab but do not click on it. The sheet will then slide into view, and will disappear when you move the pointer away from it.
- Focused view. To enter this mode, click on the Properties tab. The Properties sheet will then remain in view until you click elsewhere on the PicoScope 6 window.
- Fixed view. Click the pin icon in the title bar of the Properties sheet. The icon changes to 'pinned', and the sheet remains visible while you use the other functions of PicoScope. In this mode, you can also move the sheet to any part of the window by dragging its title bar. To hide the sheet, click the pin icon again to return to "quick view" mode. The sheet then disappears when you move the pointer away.

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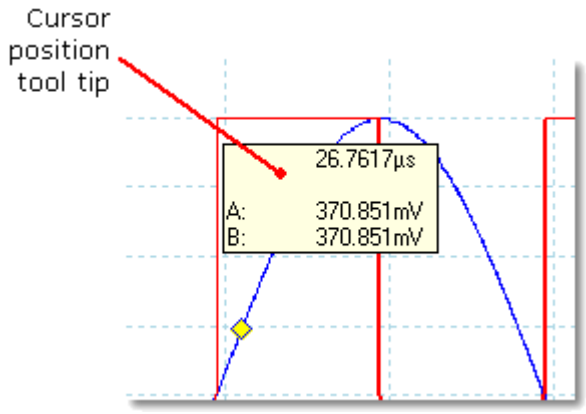
5.11 Cursor position tool tip

The cursor position tool tip is a box that displays the horizontal and vertical axis values at the cursor location. It appears temporarily when you click the background of a view, 82 In a scope view, 13 it shows time and signal values, and in a spectrum view, 14 it shows frequency and signal values.



Cursor position tool tip
in a scope view

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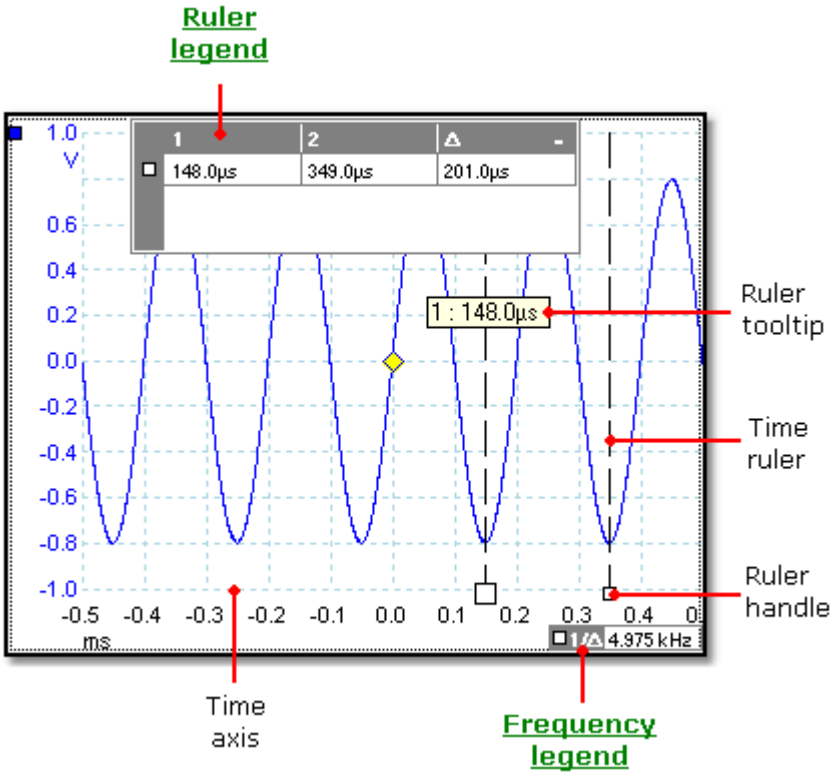
5.12 Time rulers

The time rulers measure time on a scope view [13] or frequency on a spectrum view. [14]



In the scope view [13] above, the two white squares on the time axis are the time ruler handles. You can drag these from the bottom left corner to the positions on the time axis you want to measure. The two vertical dashed lines are the time rulers. The rulers work in the same way on a spectrum view, [14] but the ruler legend shows their horizontal positions in units of frequency rather than time.

Ruler tool tip

If you point to one of the rulers, as we have done in the example above, PicoScope displays a tool tip with the ruler number and the time value of the ruler.

Ruler legend

The table at the top of the view is the ruler legend. In this example, the table shows that time ruler 1 is at 148.0 microseconds, ruler 2 is at 349.0 microseconds and the difference between them is 201.0 microseconds.

Frequency legend

The frequency legend in the bottom right-hand corner shows 1/Δ, where Δ is the time difference between the two rulers. 1/Δ is 4.975 kilohertz in this example. The accuracy of this calculation depends on the accuracy with which you have positioned the time rulers. For greater accuracy with periodic signals, use the frequency measurement [75] function built in to PicoScope. This legend appears only in scope views.

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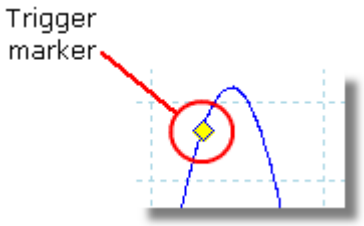
5.13 Trigger marker

The trigger marker shows the level and timing of the trigger point.



The height of the marker on the Y axis shows the level at which the trigger is set, and its position on the X axis shows the time at which it occurs.

You can move the trigger marker by dragging it with the mouse or, for numerical control, use the buttons on the Triggering toolbar 60.

Other forms of trigger marker

In post-trigger delay mode, the trigger marker is temporarily replaced by the post-trigger arrow 12 while you adjust the post-trigger delay.

When some advanced trigger types are in use, the trigger marker changes to a window marker, which shows the upper and lower trigger thresholds.

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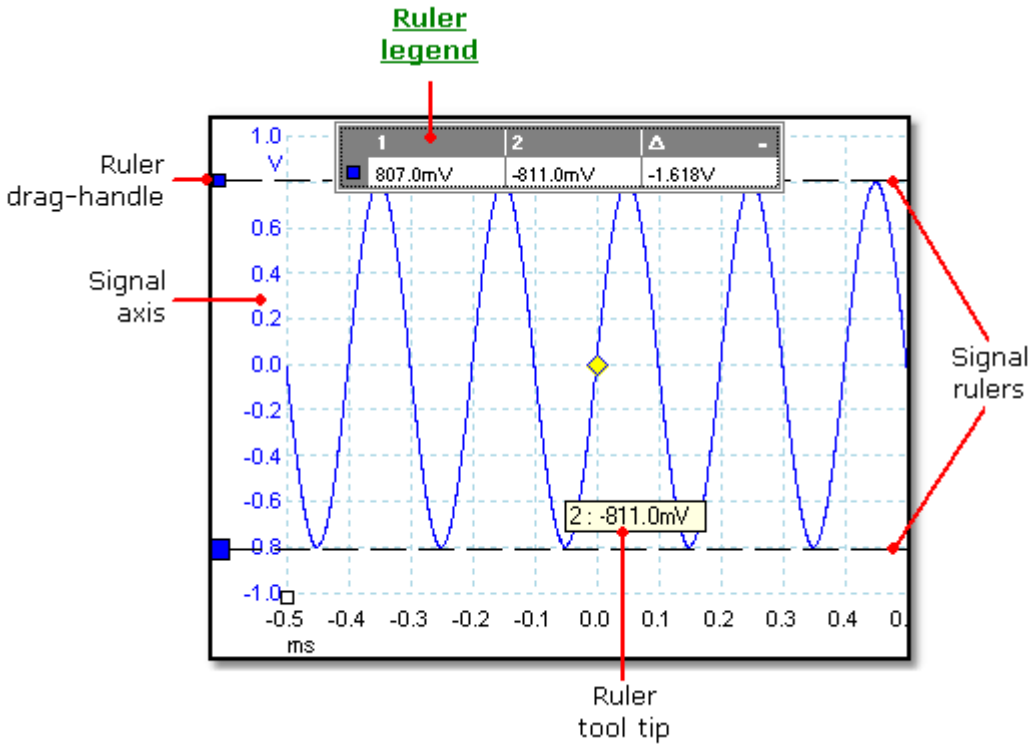
5.14 Signal rulers

The signal rulers are to help you measure signal levels with respect to ground, or signal differences, on a scope view 13 or spectrum view 14.



In the scope view 13 above, the two coloured squares to the left of the vertical axis are the ruler drag-handles. You can drag these from the top-left corner to the positions you want to measure on the waveform. The two horizontal dashed lines are the signal rulers. The signal rulers work in the same way on a spectrum view. 14

Ruler legend

The table at the top of the view is the ruler legend. In this example, the table shows that ruler 1 is at 807 millivolts, ruler 2 is at -811.0 millivolts and the difference between them is –1.618 volts. If you prefer to see the difference as a positive value, swap the positions of the two rulers by dragging them.

Ruler tool tip

If you move the mouse pointer over one of the rulers, PicoScope displays a tool tip 82 with the ruler number and the signal level of the ruler. You can see an example of this in the picture above.

5.15 Windows, views and viewports

PicoScope contains one or more views - which can be scope views 13 or spectrum views. 14 When you first open PicoScope, it contains a single scope view. You can zoom and pan 66 this to show various different waveforms based on the data that the scope device captured. If you wish, you can add more views to the PicoScope window (how? 29). Each view is a differently zoomed and panned section of the same capture.

Multiple views are always arranged in a grid. Each location in the grid is called a viewport, and can be empty or occupied by one or more views.

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5.16 Custom probes

A probe is any connector, transducer or measuring device that you connect to the input channel of your scope device 82. PicoScope has a built-in library of common probe types, such as the x1 and x10 voltage probes used with most oscilloscopes, but if your probe is not included in this list you can use the Custom Probes dialog 32 to define a new one. Custom probes can have any voltage range within the capabilities of the oscilloscope, display in any units, and have either linear or nonlinear characteristics.

Custom probe definitions are particularly useful when you wish to display the probe's output in units other than volts, or to apply linear or nonlinear corrections to the data.

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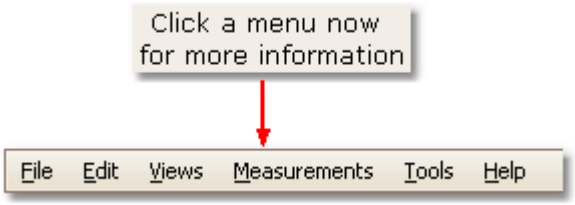
6 Menus

Menus are the quickest way to get to PicoScope's main features. The Menu bar is always present at the top of the PicoScope main window, just below the window's title bar. You can click any of the menu items, or press the Alt key and then navigate to the menu using the cursor keys, or press the Alt key followed by the underlined letter in one of the menu items.



The list of items in the menu bar may vary depending on the windows that you have open in PicoScope.

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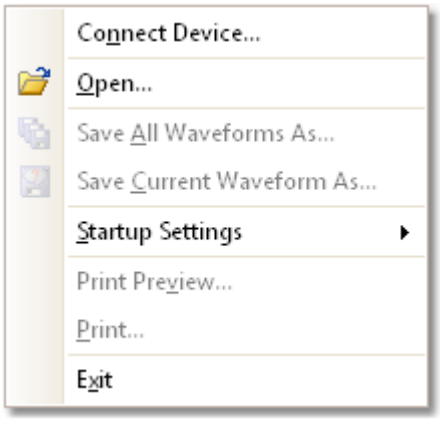
6.1 File menu

Click File on the Menu bar 21 to open the File menu.



Connect Device. This command appears only when there is no scope device connected. It opens the Connect Device dialog 48 which allows you to select the scope device you wish to use.

Open. Allows you to select the file you want to open. PicoScope can open *.psdata and *.psd files, which contain both waveform data and scope device settings, and *.pssettings and *.pss files, which contain only scope device settings. You can create your own files using the Save and Save As... commands, described below. If the file was saved using a different scope device from the one that is presently connected, PicoScope may need to modify the saved settings to suit the present device.

Save All Waveforms As. Opens the Save As dialog 23, which allows you to save the settings and waveforms for all views in various formats.

Save Current Waveform As. Opens the Save As dialog 23, which allows you to save the settings and waveforms for all views in various formats.

Startup Settings. Opens the Startup Settings dialog. 27

Print Preview. Opens the Print Preview window, which allows you to see how your workspace will be printed when you select the Print command.

Print. Opens a standard Windows Print dialog, which allows you to choose a printer, set printing options and then print the selected view.

Exit. Close PicoScope without saving any data.

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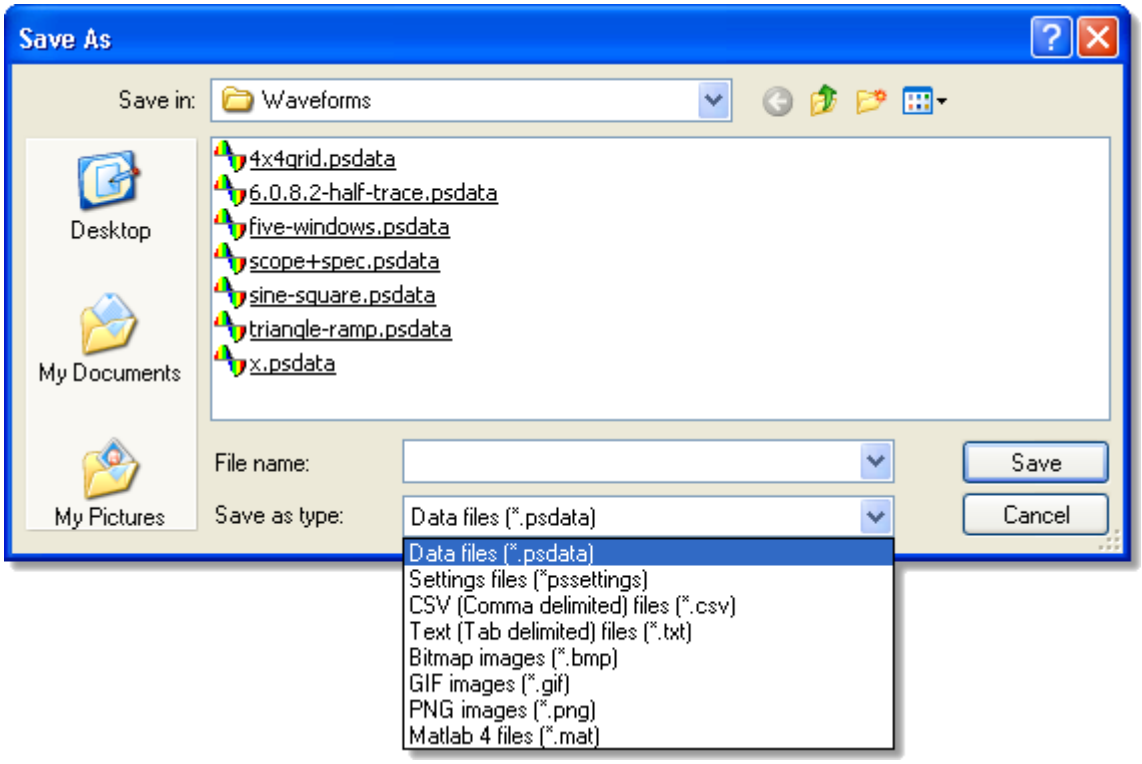
6.1.1 Save As dialog

The Save As dialog allows you to save your waveforms and settings to a file in various formats. To open it, go to the File menu 22 and click Save As.



Type your chosen file name in the File name box, and then select a file format in the Save as type box. You can save data in the following formats:

Data files (*.psdata)	Stores all waveforms and settings from the current scope device. Can be opened on any computer running PicoScope.
Settings files (*.pssettings)	Stores all settings (but not waveforms) from the current scope device. Can be opened on any computer running PicoScope.
CSV (Comma delimited) files (*.csv)	Stores waveforms as a text file with comma-separated values. This format is suitable for importing into spreadsheets such as Microsoft Excel. The first value on each line is the time stamp, and it is followed by one value for each active channel. (Details)
Text (Tab delimited) files (*.txt)	Stores waveforms as a text file with tab-separated values. The values are the same as those in the CSV format. (Details)
Bitmap images (*.bmp)	Stores the graticule 82, rulers 82 and waveforms in Windows bitmap format. The image is 800 pixels wide by 600 pixels high, in 16 million colours, and uncompressed. BMP files are suitable for importing into Windows desktop publishing programs.

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GIF images (*.gif)	Stores the graticule 82, rulers 82 and waveforms in Compuserve GIF format. The image is 800 pixels wide by 600 pixels high, in 256 colours, and compressed. GIF files are widely used to illustrate web pages.
PNG images (*.png)	Stores the graticule 82, rulers 82 and waveforms in Portable Network Graphics format. The image is 800 pixels wide by 600 pixels high, in 16 million colours, and compressed.
Matlab 4 files (*.mat)	Stores the waveform data in Matlab 4 format. (Details)

6.1.1.1 File formats for exported data

PicoScope 6 can export raw data in one of two fundamental ways:

In a text-based file

- Easy to read without special tools
- Common formats like CSV and tab-delimited can be imported into standard spreadsheet applications
- Files are very large if there are a lot of samples in the data (so files are limited to 65,536 values per channel)

Text file format details 24

In a binary file

- Files remain relatively small and can even be compressed in some situations (this means that the amount of saved data is unlimited)
- Either a special application is required to read the files or the user must write a small program to read the data from the file

If you need to save more than 65,536 values per channel, then you must use a binary file format such as the Matlab® MAT-file format.

Binary file format details 25

Data types for PicoScope 6

Regardless of whether the data types were loaded from a binary file or from a text-based file, we recommend the following data formats for storing the loaded values: -

- Sampled data (such as voltages) should use 32-bit single-precision floating-point data types.
- Times should use 64-bit double-precision floating-point data types.

6.1.1.1.1 Text formats

Text-format files exported by PicoScope 6 24 are encoded in UTF-8 format by default. This is a popular format which is capable of representing a huge range of characters whilst still retaining some compatibility with the ASCII character set if only standard Western European characters and numbers are used in the file.

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CSV (comma-separated values)

CSV files store data in the following way: -

```
Time, Channel A, Channel B
(µs), (V), (V)
-500.004, 5.511, 1.215
-500.002, 4.724, 2.130
-500, 5.552, 2.212
…
```

CSV files have a comma after each value on a line to represent a column of data and a carriage return at the end of the line to represent a new row of data. The 65,536 values per channel limit applies to CSV files to prevent excessively large files being created.

Note. Because some languages use the comma character as the decimal point, CSV files are not the best choice of format if you are working in one of these languages. Instead, try using the tab-delimited format which works in an almost identical way.

Tab-delimited

Tab-delimited files store data in the following way: -

```
Time      Channel A   Channel B
(µs)      (V)   (V)
-500.004  5.511 1.215
-500.002  4.724 2.130
-500      5.552 2.212
…
```

The files have a tab character after each value on a line to represent a column of data and a carriage return at the end of the line to represent a new row of data. These files work in any language and are a good choice for sharing data internationally. The 65,536 values per channel limit applies to tab-delimited files to prevent excessively large files being created.

6.1.1.1.2 Binary formats

PicoScope 6 can export data 24 into version 4 of the .mat binary file format. This is an open format and the full specification is freely available from the www.mathworks.com website. PicoScope 6 saves data into the MAT-File format in a specific way, which is detailed in this topic.

Importing into Matlab®

Load the file into your workspace using this syntax: -

```
load myfile
```

Each channel's data is stored in array variable named by the channel. So, the sampled data for channels A to D would be in four arrays named A, B, C and D.

There is only one set of times data for all channels and this is loaded in one of two possible formats: -

1. A start time, an interval and a length. The variables are named Tstart, Tinterval and Tlength.
1. An array of times (sometimes used for ETS data). The time array is named T.

If the times are loaded in as Tstart, Tinterval and Tlength then you can use the following command to create the equivalent array of times: -

```
T = [Tstart : Tinterval : Tstart + (Tlength – 1) * Tinterval];
```


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Exploring the file format

The full file specification, available from www.mathworks.com, is comprehensive so this guide does not describe the entire format. Instead, this guide describes enough of the format to allow you to get data from the file and use it in your own program.

The variables described above (under Importing into Matlab® 25) are stored in a series of data blocks, each preceded by a header. Each variable has its own header and data block and the corresponding variable names are stored with them (such as A, B, Tstart). The following sections describe how to read each variable from the file.

The order of the data blocks is not specified, so programs should look at the variable names to decide which variable is currently being loaded.

The header

The file consists of a number of data blocks preceded by 20-byte headers. Each header contains five 32-bit integers (as described in the table below).

Bytes	Value
0 – 3	Data format (0, 10 or 20)
4 – 7	Number of values
8 – 11	1
12 – 15	0
16 – 19	Name length

Data format

The 'Data format' in the first 4-bytes describes the type of numerical data in the array.

Value	Description
0	Double (64-bit floating point)
10	Single (32-bit floating point)
20	Integer (32-bit)

Number of values

The 'Number of values' is a 32-bit integer describing the number of numerical values in the array. This value may be 1 for variables that only describe 1 value; but for arrays of samples or times, expect this to be a large number.

Name length

The 'Name length' is the length of the name of the variable as a 'null terminated' 1-byte per character ASCII string. The last null terminating character ('\0') is included in the 'Name length' so if the variable name is "TStart" (same as 'TStart\0') then the name length will be 7.

The data block

The data block begins with the name of the variable (such as A, Tinterval) and you should read in the number of bytes described by the 'Name length' part of the header (not forgetting that the last byte in the string is '\0' if your programming language needs to take account of this).

The remaining part of the data block is the actual data itself, so read in the number of values described in the 'Number of values' part of the header. Remember to take account of the size of each value as described in the 'Data format' part of the header.

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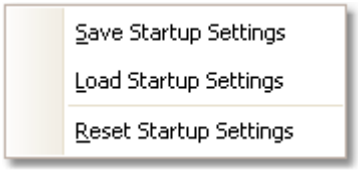
Channel data such as voltages in variables such as A and B are stored as 32-bit single-precision floating-point data types. Times such as Tstart, Tinterval and T are stored as 64-bit double-precision floating-point data types. Tlength is stored as a 32-bit integer.

6.1.2 Startup Settings menu

The Startup Settings menu allows you to load, save and restore the PicoScope 6 startup settings. To open it, go to the File menu 22 and click Startup Settings.



Save Startup Settings. Saves your current settings ready for when you next select Load Startup Settings. These settings are remembered from one session of PicoScope 6 to the next.

Load Startup Settings. Returns to the settings you created with the Save Startup Settings command.

Reset Startup Settings. Deletes the startup settings you created with the Save Startup Settings command.

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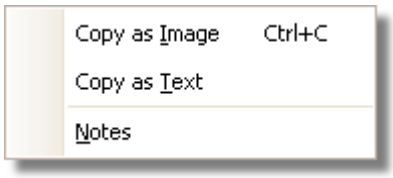
6.2 Edit menu

Click Edit on the Menu bar 21.



Copy as Image. Copies the active view to the clipboard as a bitmap. You can then paste the image into any application that accepts bitmap images.

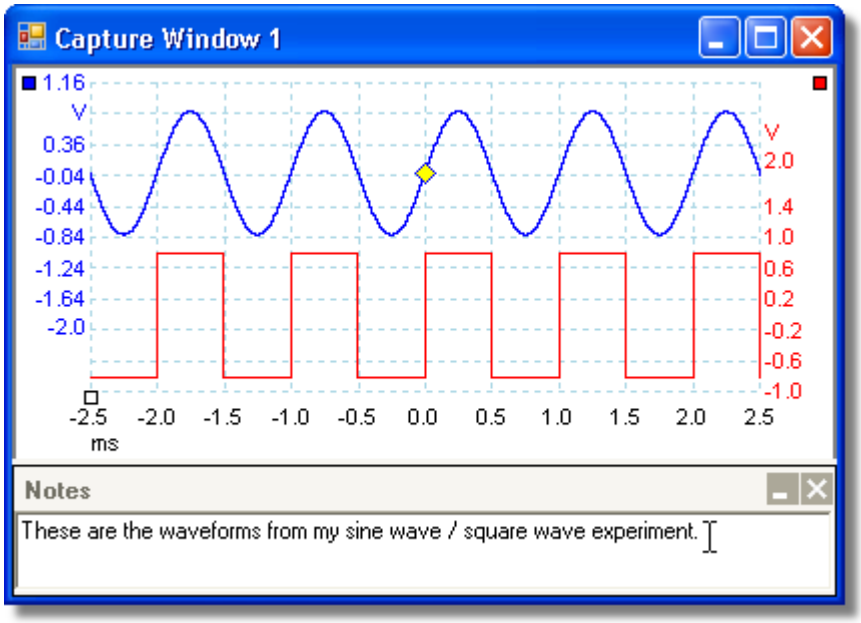
Copy as Text. Copies the data in the active view to the clipboard as text. You can paste the data into a spreadsheet or other application. The text format is the same as that used by the Save As *.txt command, and is explained in the Save As dialog 23 topic.

Notes. Opens a Notes area 28 at the bottom of the PicoScope window. You can enter any explanatory text that you wish to in this area.

6.2.1 Notes area

A Notes area can be displayed at the bottom of the PicoScope window. You can enter any text you wish in this area. You can also copy formatted text from another program and paste it here.

To display the Notes area, click on the Edit menu, then select Notes.



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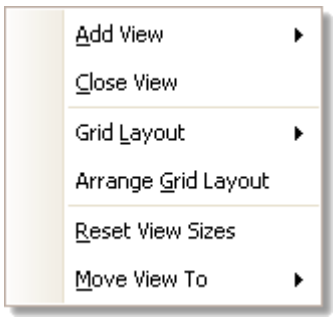
6.3 Views menu

Click Views on the Menu bar 21 or right-click on a view 19. This menu controls the layout of PicoScope views 82.



The contents of the Views menu may vary depending on the location of the cursor and the state of the PicoScope window. It sometimes incorporates the Measurements menu 30.

Add view: Adds a view of the selected type ("scope 13" or "spectrum 14"). In automatic mode (the default), PicoScope will create a new grid or expand the existing grid to make room for the new view, up to a limit of four views. Any further views will be added as tabs in existing viewports. If you have selected a standard or custom grid layout, PicoScope will not change it.

Close view: Removes a view from the PicoScope window. In automatic mode (the default), PicoScope will rearrange the grid to make the best use of the remaining space. If you have selected a standard or custom grid layout, PicoScope will not change it.

Grid Layout: The grid layout defaults to "Automatic" mode, in which PicoScope automatically arranges views in a grid. You can also select one of the standard grid layouts or create a custom layout, which PicoScope will not change as you add or remove views.

Arrange grid layout: Adjusts the grid layout to fit the number of views. Moves any tabbed views to empty viewports. PicoScope may change the number of viewports.

Reset view sizes: If you have resized any of the views by dragging the vertical or horizontal separator bars between viewports, this option will reset all the viewports to their original sizes.

Move view to: Lets you move views backward or forward in the grid, or to specified viewports. You can achieve the same effect by dragging views by their name tabs and dropping them in a new place. See How to move a view 72.

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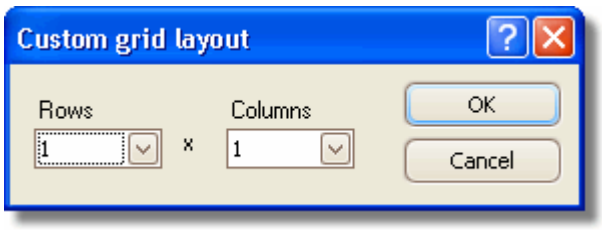
6.3.1 Custom grid layout dialog

This dialog allows you to lay out the view 82 grid with the number of rows and columns that you want, up to a limit of four rows and four columns. You can then drag the views to different locations in the grid.

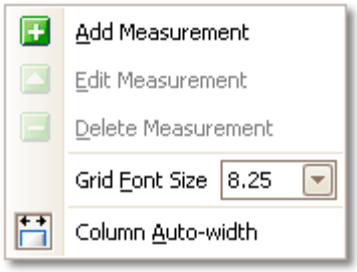


Where to find it

Right-click on the PicoScope window to get the Views menu 29, then select the Grid Layout submenu and then the Custom layout... command. You can also find the View menu on the Menu bar 21.

6.4 Measurements menu

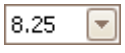
Click Measurements on the Menu bar 21.



Add measurement. Adds a row to the measurements table 11, and opens the Edit Measurement Dialog 31. You can also find this button on the Measurements toolbar 52.

Edit measurement. This takes you to the Edit Measurement Dialog 31. You can find this button on the Measurements toolbar 52, or you can edit a measurement by double-clicking on a row of the measurements Table 11.

Delete measurement. Removes the selected row from the measurements table 11. You can also find this button on the Measurements toolbar 52.



Grid font size. Sets the font size for the entries in the measurements table 11.

Column Auto-width. If this button is pressed, the columns of the measurements table 11 will continually adjust to fit the contents whenever the table changes. Click again to release the button.

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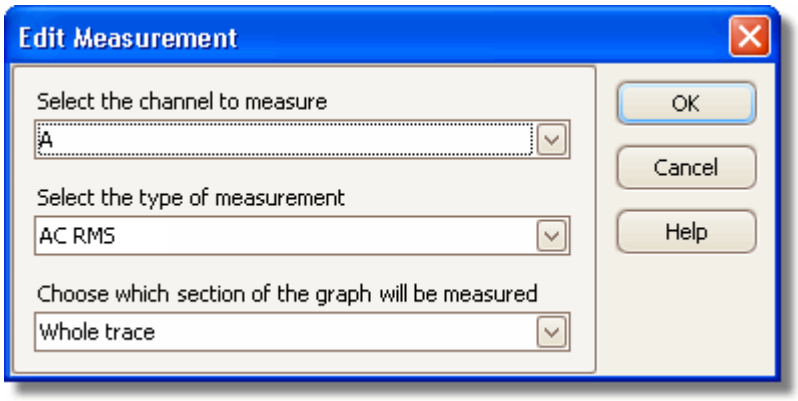
6.4.1 Add / Edit Measurement dialog

This dialog allows you to add a measurement of a waveform to the selected view, 19 or edit an existing measurement. PicoScope automatically refreshes the measurement every time it updates the waveform. If this is the first measurement for the view, PicoScope will create a new measurements table 11 to display the measurement; otherwise, it will add the new measurement to the bottom of the existing table.



Where to find it

Click the Add Measurement or Edit Measurement button on the Measurements toolbar 52 or in the Views menu 29, or double-click a measurement in the measurements table 11.

Channel: Select one of the scope device 82's channels to measure.

Type: PicoScope can calculate a wide range of measurements for waveforms. See Measurement Types 75 for details.

Section: You can measure the whole trace, just the section between rulers 82, or a single cycle that you point to using one of the rulers.

Where to find it

Click the Edit Measurement button on the Measurements toolbar 52 or in the Views menu 29,

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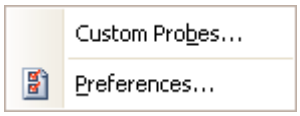
6.5 Tools menu

Click Tools on the Menu bar 21.

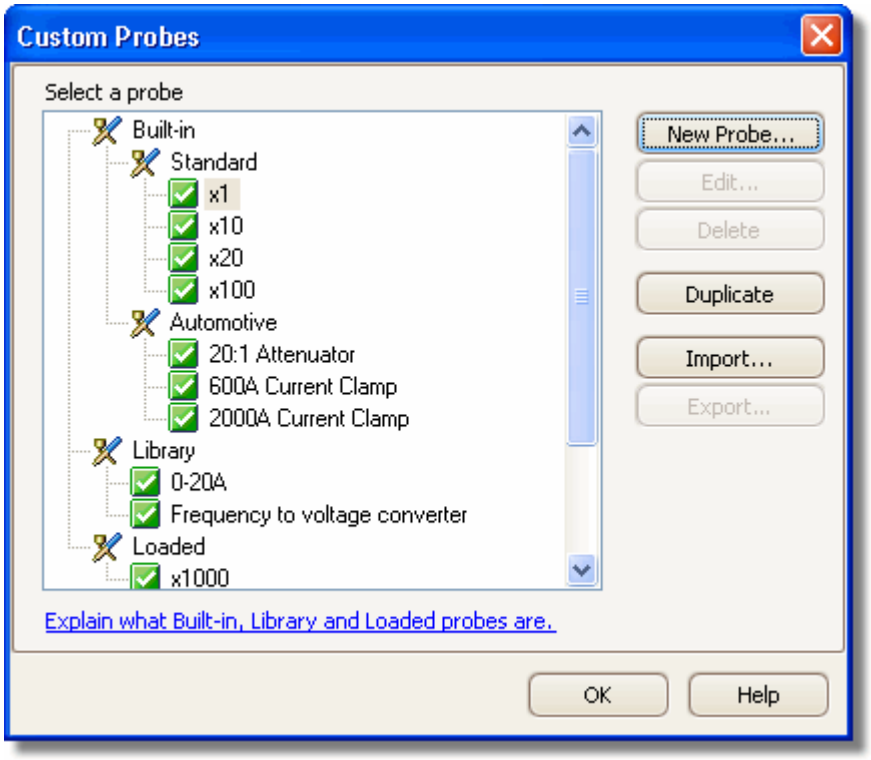


Custom Probes: Opens the Custom probes 32 dialog, which allows you to define new probes and copy, delete, move and edit existing ones.

Preferences: Opens the Preferences dialog 44, which contains various options that control PicoScope's behaviour.

6.5.1 Custom Probes dialog

This dialog allows you to define your own probes and set up custom probes 20. To open this dialog, choose Custom Probes in the Tools menu 32 or click the Channel Advanced Options button.



Understanding the probe list

All the probes that PicoScope knows about are listed under three main headings: Built-in, Library and Loaded. The probe list is preserved between sessions, so that PicoScope will never forget your custom probes unless you delete them.

- Built-in probes. The built-in probes are supplied by Pico Technology and do not change unless you download an authorised update from us. As a safeguard, PicoScope does not allow you to edit or delete these probes. If you want to modify one of them, you can copy it to your library by clicking Duplicate, and then edit the copy in your library.
- Library probes. These are the probes that you have created using any of the methods described in this topic. You can edit, delete or duplicate any of these probes by clicking the appropriate button in this dialog.

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- Loaded probes. Probes in PicoScope data files (*.psdata) or settings files (*.pssettings) that you have opened appear here until you copy them to your library. You cannot edit or delete these probes directly, but you can click Duplicate to copy them to your library where you can edit them. You can also import probes from the custom ranges stored in PicoScope 5 *.psd and *.pss files, but these lack many of the features provided by PicoScope 6. (See "Upgrading from PicoScope 5 2" for more details.)

Adding a new probe to your library

There are three ways to create a new probe:

1. Create a duplicate of an existing probe as described above.
2. Click New Probe... to define a new probe.
3. Click Import to load a probe definition from a *.psprobe file and add it to your library. These files are normally supplied by Pico, but you can also create your own by defining a new probe and then clicking Export.

The second and third methods open the Custom Probe Wizard 33 to guide you through the probe definition process.

6.5.2 Custom Probe wizard

The Custom probe wizard allows you to define custom probes 20 and set up custom ranges.

The first dialog in the series is either the Create a new Custom Probe dialog 34 or the Edit an existing Custom Probe dialog 35.

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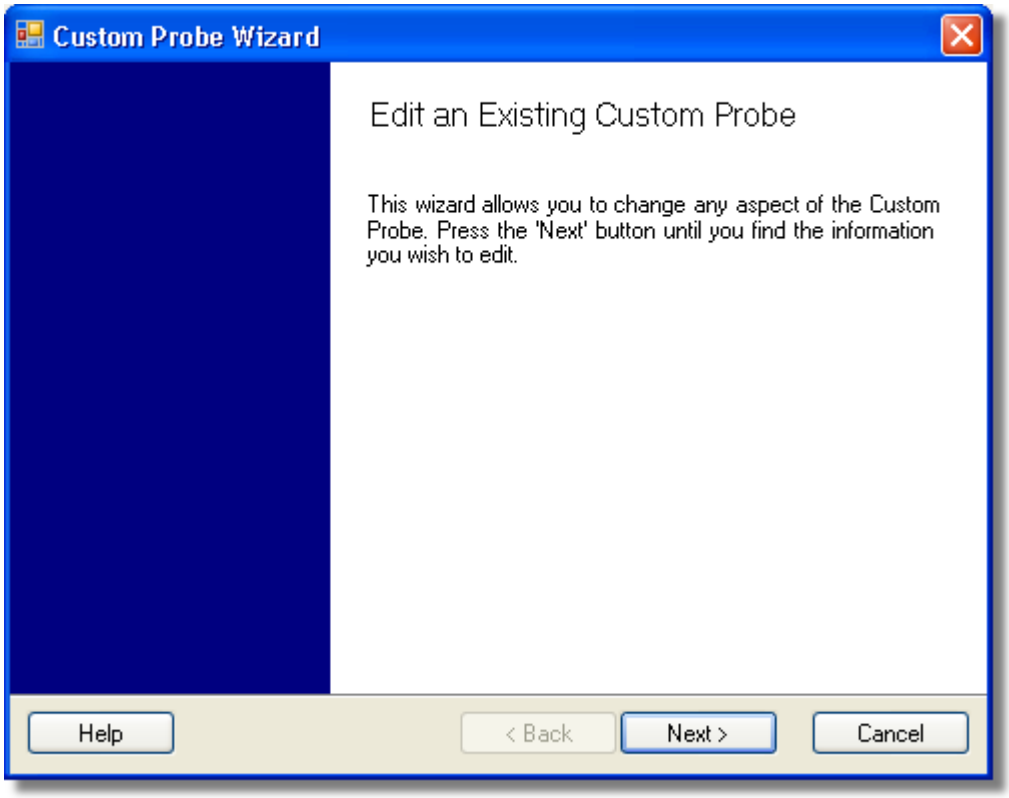
6.5.2.1 Create New Custom Probe dialog

This dialog introduces you to the process for creating a new custom probe. To open it, click the New Probe button in the Custom Probes dialog 32.


Custom Probe Wizard
Edit an Existing Custom Probe
This wizard allows you to change any aspect of the Custom Probe. Press the 'Next' button until you find the information you wish to edit.
Help
< Back
Next >
Cancel

How to use the dialog

Click Next to continue to the Probe Output Units dialog 36.

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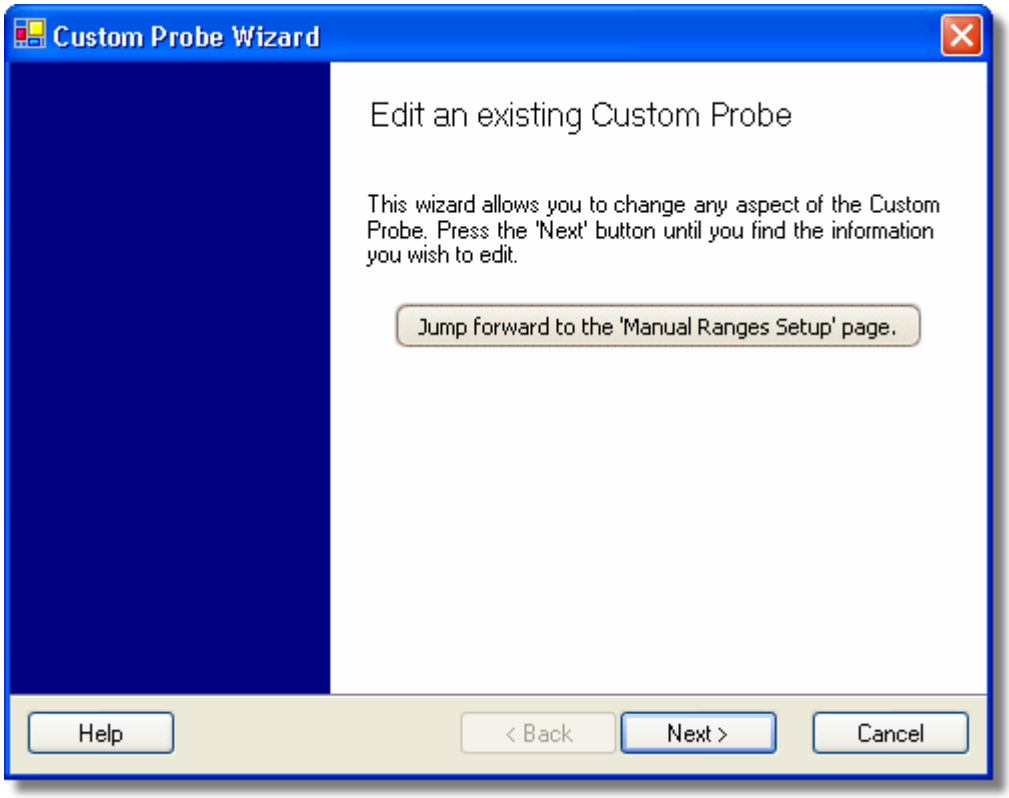
6.5.2.2 Edit Existing Custom Probe dialog

This dialog introduces you to the process for editing an existing custom probe. Get here by clicking the Edit button in the Custom Probes dialog 32.


Custom Probe Wizard
Edit an existing Custom Probe
This wizard allows you to change any aspect of the Custom Probe. Press the 'Next' button until you find the information you wish to edit.
Jump forward to the 'Manual Ranges Setup' page.
Help
< Back
Next >
Cancel

How to use the dialog

Click Next to continue to the Probe Output Units dialog 36, where you can edit the custom probe.

Click Jump forward... if you have already set up the custom probe's basic characteristics and want to add or change a custom range manually.

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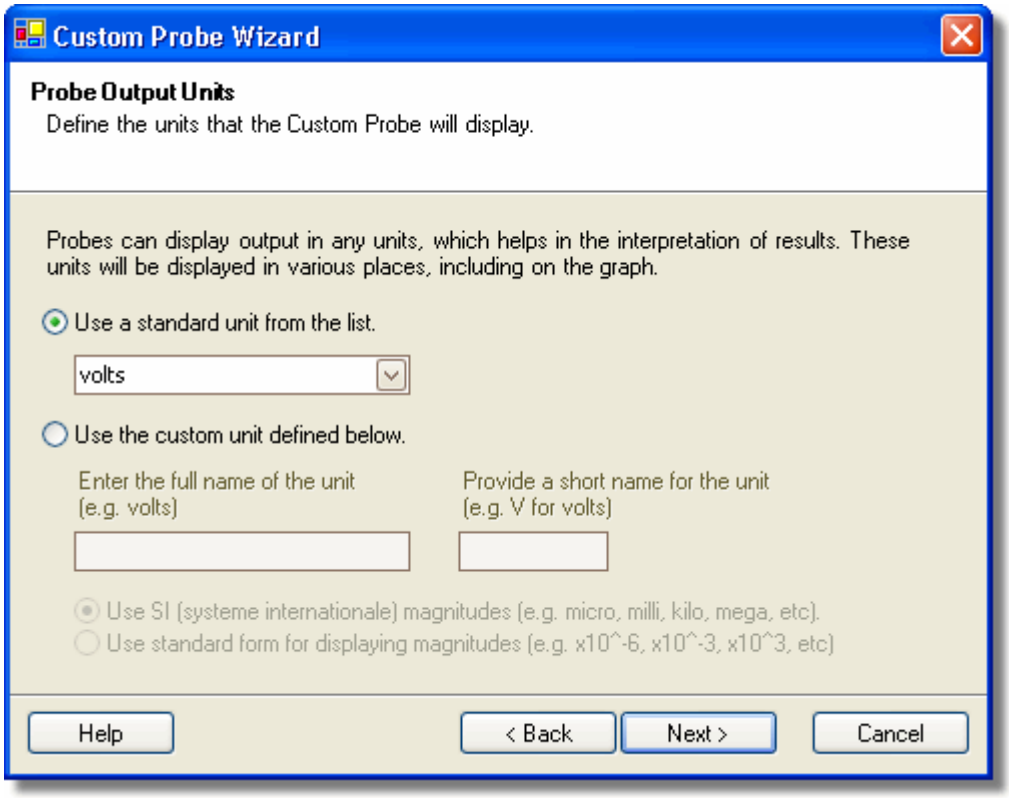
6.5.2.3 Probe Output Units dialog

This dialog follows the Create new Custom Probe dialog 34. It allows you to choose the units that PicoScope will use to display the output of your custom probe 82.


Custom Probe Wizard
Probe Output Units
Define the units that the Custom Probe will display.
Probes can display output in any units, which helps in the interpretation of results. These units will be displayed in various places, including on the graph.
Use a standard unit from the list.
volts
Use the custom unit defined below.
Enter the full name of the unit (e.g. volts)
Provide a short name for the unit (e.g. V for volts)
Use SI (systeme internationale) magnitudes (e.g. micro, milli, kilo, mega, etc).
Use standard form for displaying magnitudes (e.g. x10^-6, x10^-3, x10^3, etc)
Help
< Back
Next >
Cancel

How to use the dialog

- To choose a standard SI unit, click Use a standard unit from the list and select one from the list.
- To enter a custom unit, click Use the custom unit defined below and type the unit name and symbol.

- Click Next to continue to the Scaling Method dialog 37.
- Click Back to return to the Create New Custom Probe dialog 34 if this is a new probe, or the Edit Existing Custom Probe dialog 35 if this is an existing probe.

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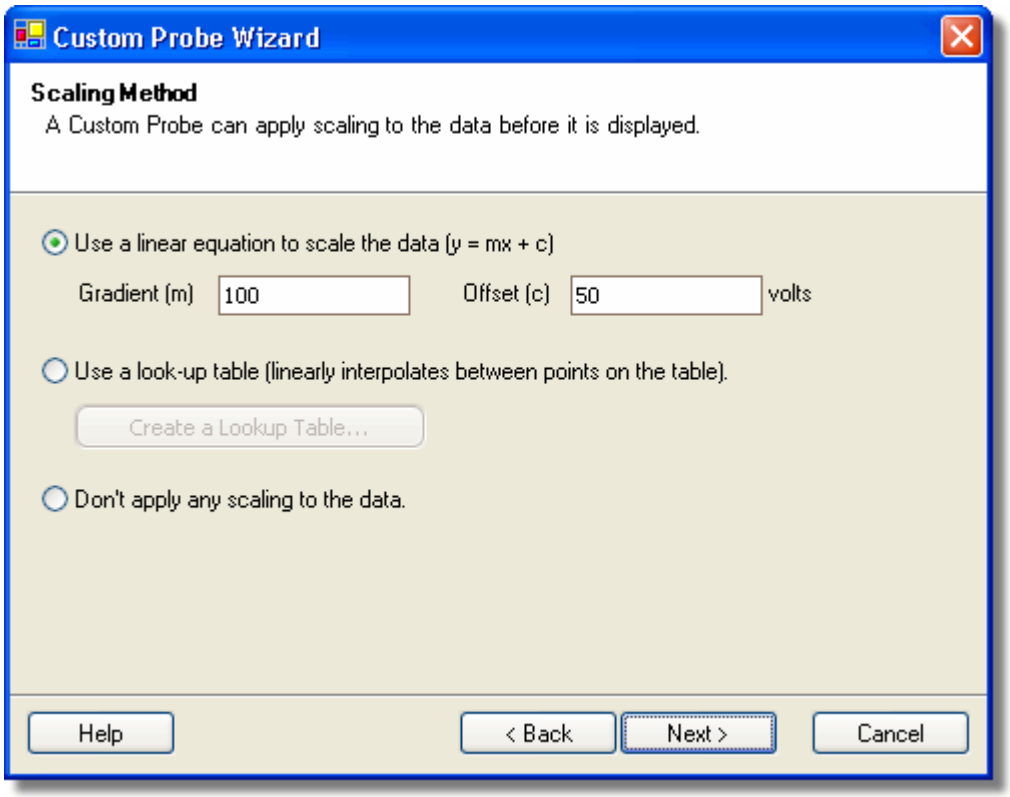
6.5.2.4 Scaling Method dialog

This dialog follows the Probe Output Units dialog 36. It allows you to define the characteristic that PicoScope will use to convert the probe's voltage output to a measurement on the display.


Custom Probe Wizard
Scaling Method
A Custom Probe can apply scaling to the data before it is displayed.
Use a linear equation to scale the data (y = mx + c)
Gradient (m)
100
Offset (c)
50
volts
Use a look-up table (linearly interpolates between points on the table).
Create a Lookup Table...
Don't apply any scaling to the data.
Help
< Back
Next >
Cancel

How to use the dialog

- If you do not require any scaling or offset, click the Don't apply any scaling button.
- If the probe requires linear scaling, click the Use a linear equation button and enter the gradient (or scale factor) *m* and the offset *c* in the equation $y = mx + c$, where *y* is the displayed value and *x* is the probe's voltage output.
- If you wish to apply a nonlinear function to the probe's output, choose Use a look-up table..., then click the Create a Lookup Table... button to create a new lookup table. This will take you to the Lookup-table Scaling dialog 38.
- Click Next to continue to the Range Management dialog 39.
- Click Back to return to the Probe Output Units dialog 36.

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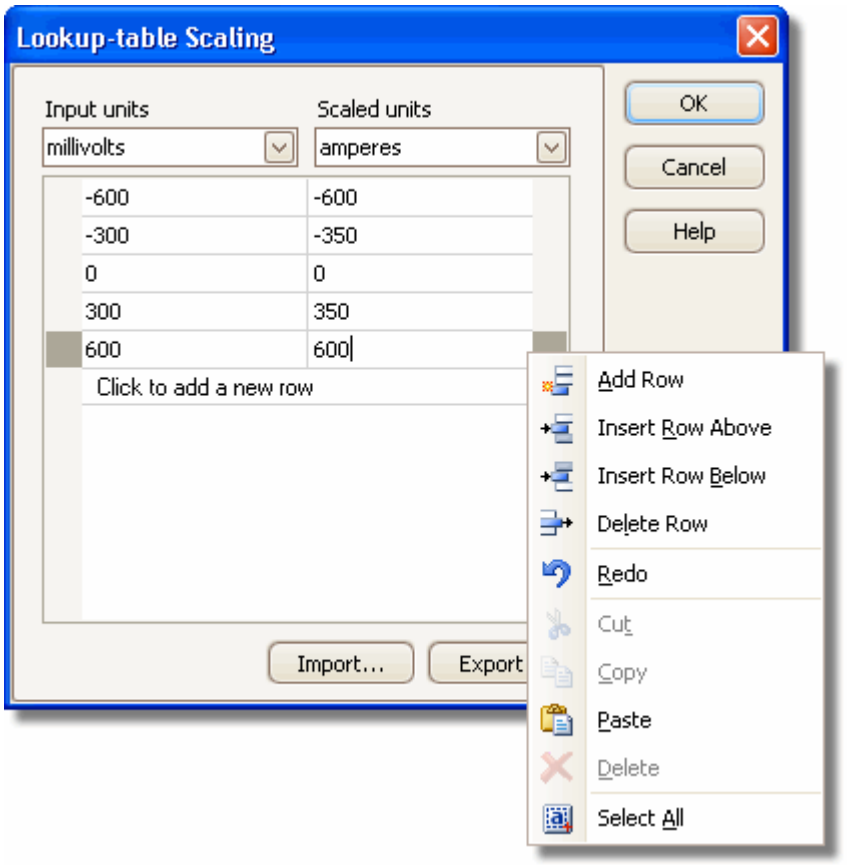
6.5.2.4.1 Lookup-table Scaling dialog

This dialog allows you to enter a look-up table to calibrate a custom probe. You can get here by clicking the Create a Look-up Table button or Edit the Lookup Table... button in the Scaling Method dialog 37.



Editing the Look-up Table

First, select suitable values in the Input units and Scaled units drop-down boxes. For example, if your probe is a current clamp that outputs one millivolt per ampere over the range -600 to +600 amperes, select Input units of millivolts and Output units of amperes.

Next, enter some data in the scaling table. Click the first empty cell at the top of the table and type "-600", then hit the Tab key and type "-600". When you are ready to enter the next pair of values, press the Tab key again to start a new row. You can also right-click on the table to obtain a more detailed menu of options, as shown in the picture. In the example above, we have entered a slightly nonlinear response; if the response had been linear then it would have been easier to use the linear option in the Scaling Method Dialog 37.

Import/Export

Using the Import and Export buttons, you can fill the look-up table from data in a comma-separated or tab-delimited text file, and save the look-up table to new file.

Finishing

Clicking OK or Cancel will return you to the Scaling Method dialog 37.

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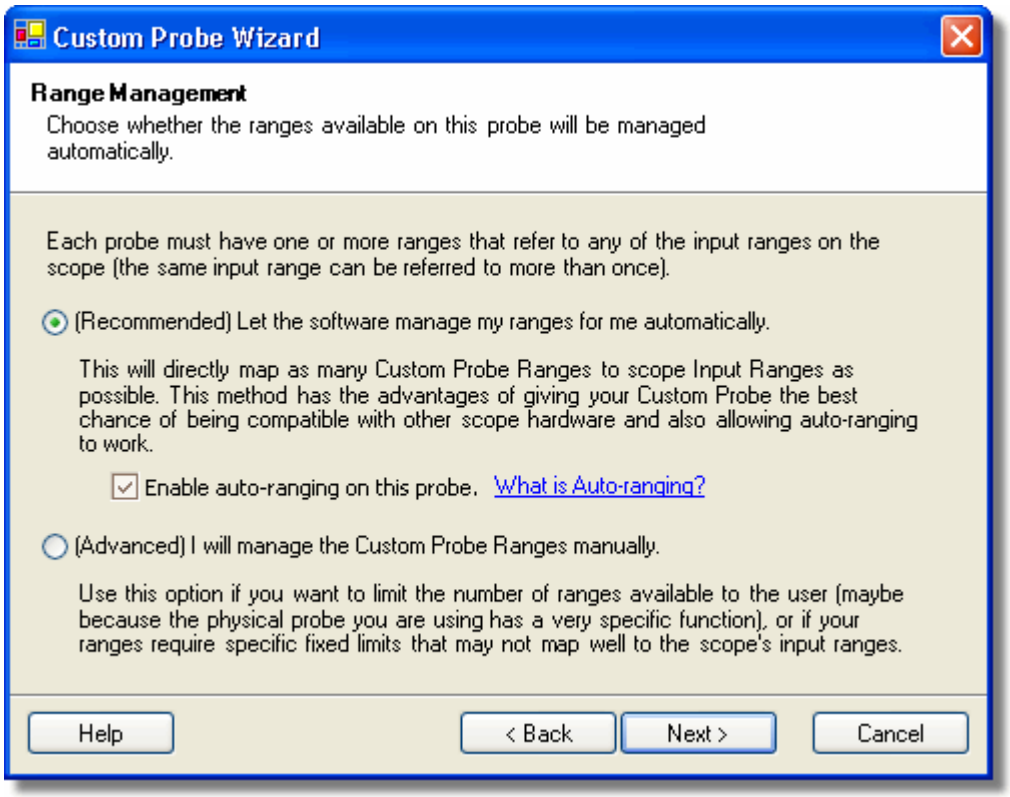
6.5.2.5 Range Management dialog

This dialog follows the Scaling Method dialog 37. It allows you to override PicoScope's automatic range-creation feature for custom probes. In most cases, the automatic procedure will be ideal.


Custom Probe Wizard
Range Management
Choose whether the ranges available on this probe will be managed automatically.
Each probe must have one or more ranges that refer to any of the input ranges on the scope (the same input range can be referred to more than once).
(Recommended) Let the software manage my ranges for me automatically.
This will directly map as many Custom Probe Ranges to scope Input Ranges as possible. This method has the advantages of giving your Custom Probe the best chance of being compatible with other scope hardware and also allowing auto-ranging to work.
Enable auto-ranging on this probe.
What is Auto-ranging?
(Advanced) I will manage the Custom Probe Ranges manually.
Use this option if you want to limit the number of ranges available to the user (maybe because the physical probe you are using has a very specific function), or if your ranges require specific fixed limits that may not map well to the scope's input ranges.
Help
< Back
Next >
Cancel

How to use the dialog

- If you select Let the software manage my ranges for me automatically, then clicking Next will take you to the Custom Probe Identification dialog 43. PicoScope's automatic ranges should be ideal for most applications.
- If you select I will manage the Custom Probe Ranges manually, clicking Next will take you to the Manual Ranges Setup dialog 40.
- Click Back to return to the Scaling Method dialog 37.

What is Auto-ranging?

When the Auto-ranging function is selected, PicoScope continually monitors the input signal and adjusts the range when necessary to allow it to display the signal with maximum resolution. This function is available on all standard ranges, and can be used with custom ranges only if you select Let the software manage my ranges for me automatically in this dialog.

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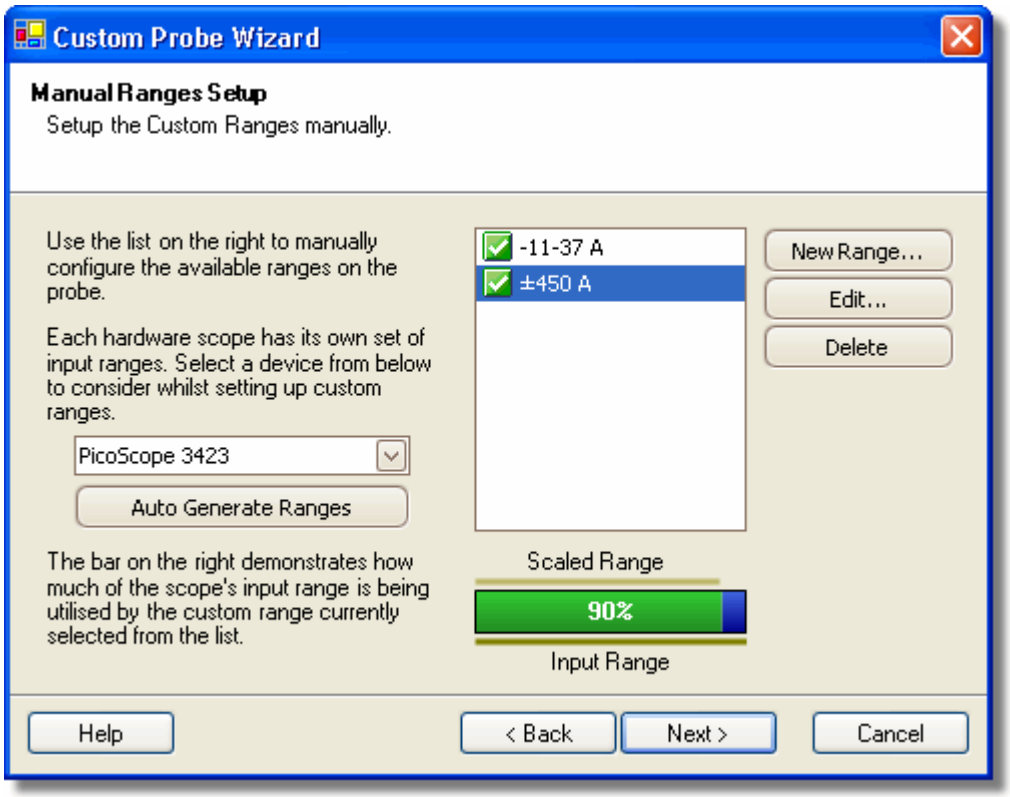
6.5.2.6 Manual Ranges Setup dialog

This dialog appears when you select the Advanced option in the Range Management dialog [39] and then click Next >. It allows you to create ranges manually for your custom probe.


Custom Probe Wizard
Manual Ranges Setup
Setup the Custom Ranges manually.
Use the list on the right to manually configure the available ranges on the probe.
Each hardware scope has its own set of input ranges. Select a device from below to consider whilst setting up custom ranges.
PicoScope 3423
Auto Generate Ranges
The bar on the right demonstrates how much of the scope's input range is being utilised by the custom range currently selected from the list.
-11-37 A
±450 A
New Range...
Edit...
Delete
Scaled Range
90%
Input Range
Help
< Back
Next >
Cancel

How to use the dialog

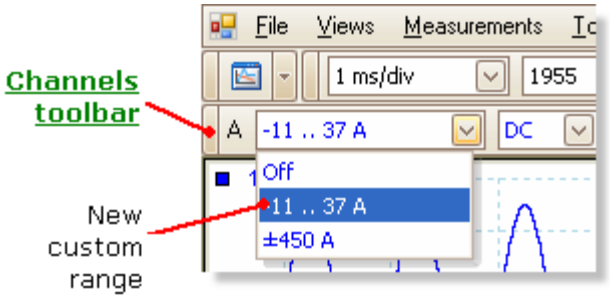
If you wish, you can click Auto Generate Ranges and the program will create a number of ranges for the selected device. This will create the same list of ranges that you would have obtained by selecting Let the software manage my ranges for me automatically in the previous dialog. When you select a range, a diagram below the list will show its relationship to the scope device's input range — this is explained further under Edit range dialog [41]. You can then edit the ranges by clicking Edit, or you can also add a new range by clicking New Range. Both of these buttons take you to the Edit Range dialog [41].

Click Next to continue to the Custom Probe Identification dialog [43].

Click Back to return to the Range Management dialog [39].

How to use a new custom range

After you have created a custom range, it will appear in the drop-down list of ranges in the channels toolbar [50], like this:



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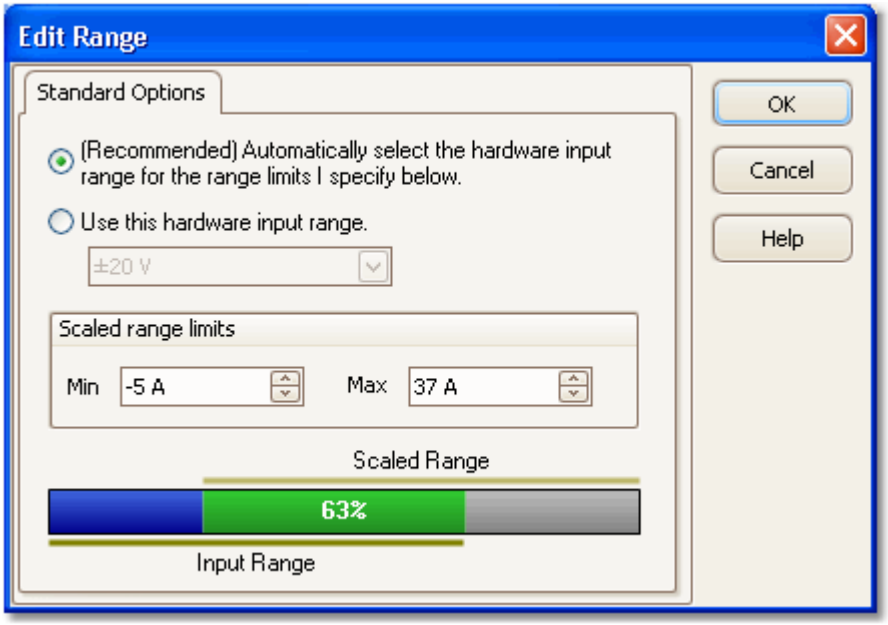
6.5.2.6.1 Edit Range dialog

This dialog allows you to edit a manual range for a custom probe.

You can get here by clicking the Edit or New Range buttons in the Manual Ranges Setup dialog 40.



Automatic mode

If you leave the "Automatic" radio button pressed, the program will automatically determine the best hardware input range for the device as you change the Scaled range limits. This is the best mode to use for almost all ranges. You should set the Scaled range limits to the maximum and minimum values you wish to see on the vertical axis of the scope display.

Fixed range mode

If you press the "Hardware input range" radio button and select a hardware input range from the drop-down box, PicoScope will then use that hardware input range whatever scaled range limits you choose. Set the upper and lower scaled range limits to the limits you wish to appear at the top and bottom of the vertical axis in PicoScope's scope view. 13

What is an input range?

An input range is the signal range, usually in volts, on the input channel of the scope device 82. Your scaled range should match this as closely as possible to make the most of the scope's resolution.

What is a scaled range?

The scaled range is the range that will appear on the vertical axis of the scope display when the probe is selected.

The scaling that you chose on the Scaling Method 37 page defines the relationship between the input range and the scaled range. This dialog enables you to set up ranges to display the scaled data on the scope view.

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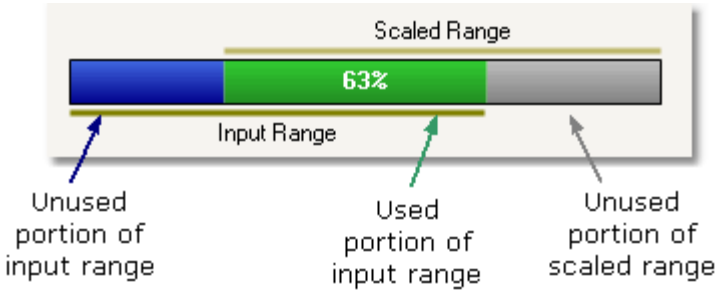
The range utilisation bar

This diagram at the bottom of the dialog represents the relationship between the scaling and the hardware input range of the scope device.



- Green - The section of the input range that is used by the scaled range. This should be as large as possible, to maximise the use of the scope device's resolution.
- Blue - Areas of the input range that are not being used. These indicate wasted resolution.
- Grey - Parts of the scaled range that are not covered by the input range. These will result in wasted space on the graph. The range utilisation bar may not represent these areas accurately when non-linear scaling is being used, so you should always test the scaled range limits on the scope view.

Finishing

Clicking OK or Cancel will return you to the Manual Ranges Setup dialog 40.

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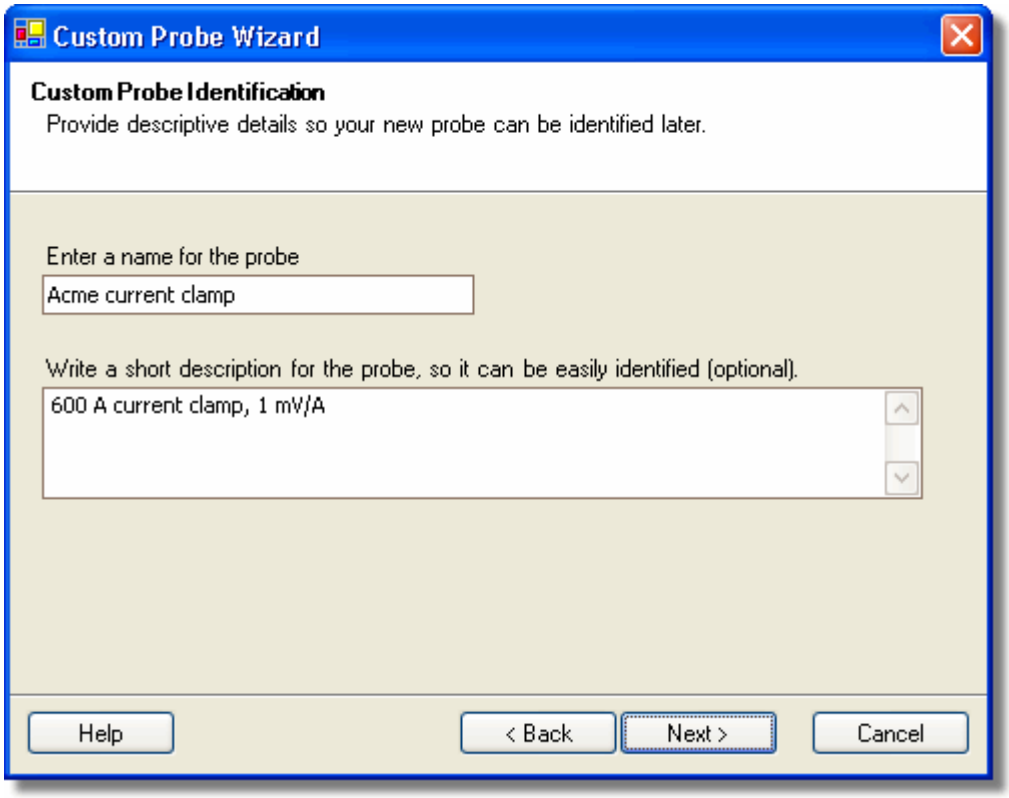
6.5.2.7 Custom Probe Identification dialog

This dialog follows the Range Management dialog. 39 It allows you to enter text to identify the custom probe.


Custom Probe Wizard
Custom Probe Identification
Provide descriptive details so your new probe can be identified later.
Enter a name for the probe
Acme current clamp
Write a short description for the probe, so it can be easily identified (optional).
600 A current clamp, 1 mV/A
Help
< Back
Next >
Cancel

How to use the dialog

Click Back to return to the Range Management dialog 39 (or the Manual Ranges Setup dialog 40 if you chose manual setup).

- The probe name will appear in the probe list.
- The description is not used in the present version of the software.

Fill in the text fields and click Next to continue to the Custom Probe Finished dialog. 44

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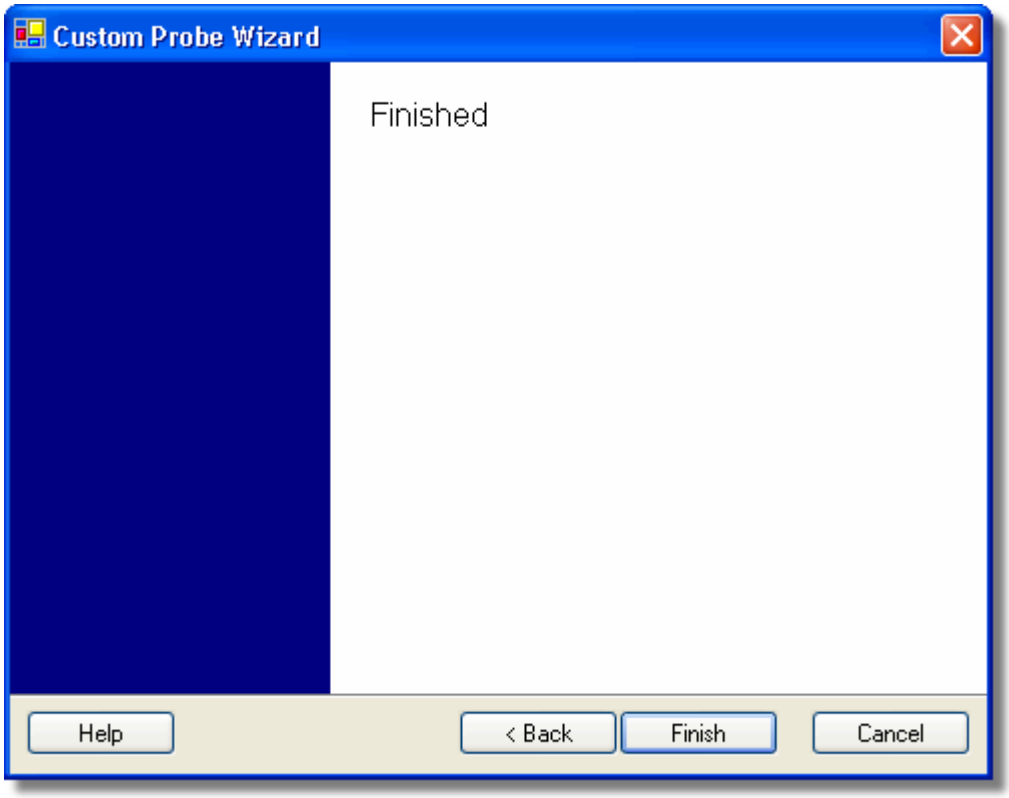
6.5.2.8 Custom Probe Finished dialog

This dialog follows the Custom Probe Identification dialog 43. It displays a summary of the custom probe that you have just set up.



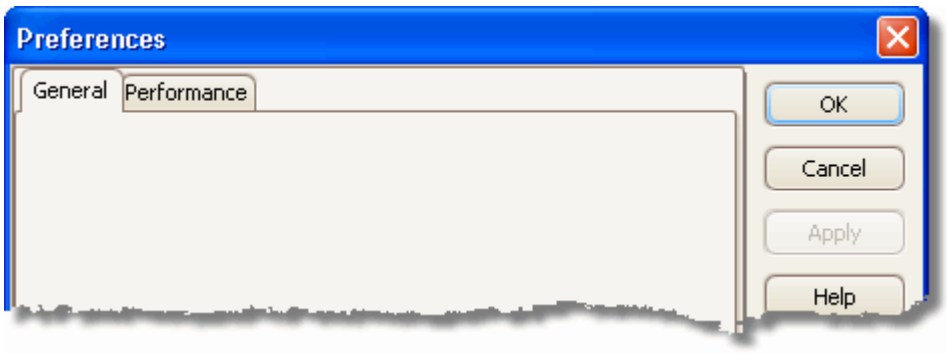
How to use the dialog

Click Back to return to the Custom Probe Identification dialog 43.

Click Finish to accept your custom probe settings and return to the Custom Probes dialog 32.

6.5.3 Preferences dialog

This dialog allows you to set miscellaneous options for the PicoScope software. Click one of the tabs on the screen shot below to learn more.



Where to find it

Click the Preferences command in the Tools menu 32 on the Menu bar 21.

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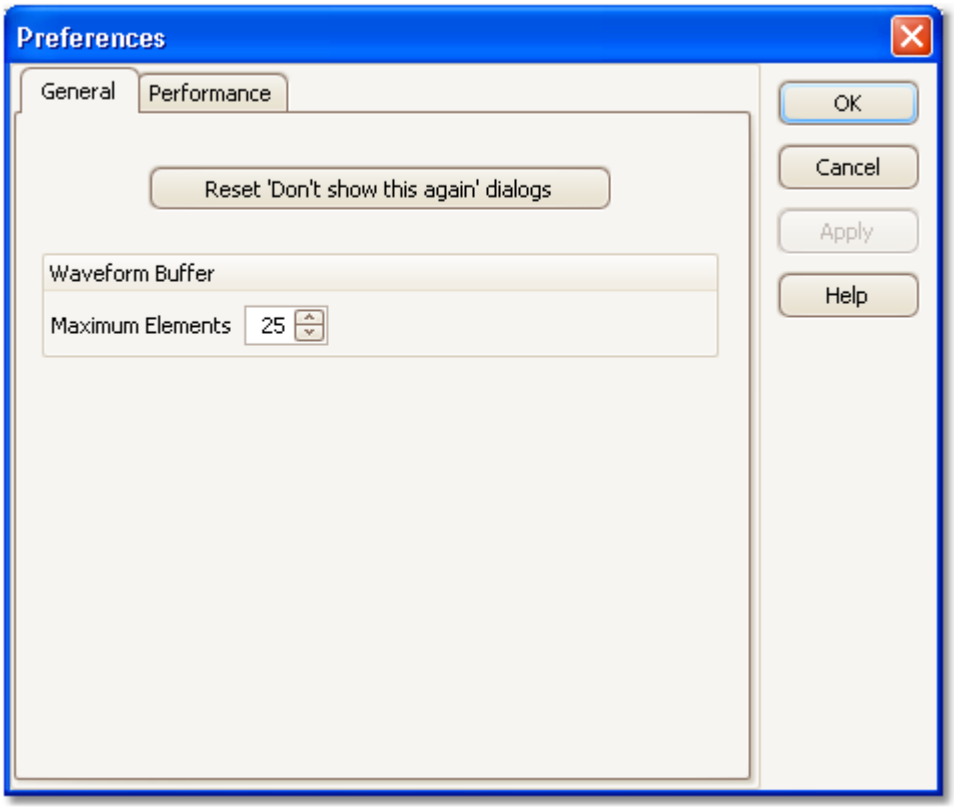
6.5.3.1 General dialog

This dialog contains general controls for PicoScope.



Reset	Click this button to restore any missing dialogs that you asked PicoScope not to show again.
Waveform Buffer	Maximum Elements: This is the maximum number of waveforms that PicoScope will store in the waveform buffer 50. The actual number of waveforms stored will depend on the available memory and the number of samples in each waveform.

Where to find it

Click the Preferences command in the Tools menu 32 on the Menu bar 21.

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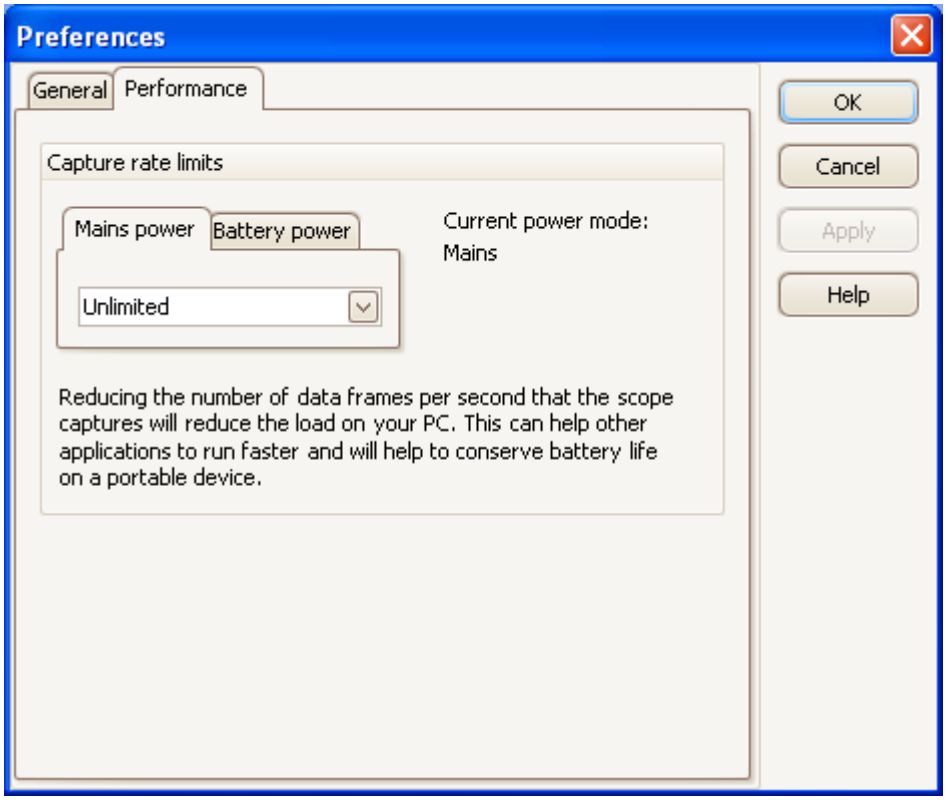
6.5.3.2 Performance dialog

The performance settings limit the speed at which PicoScope captures data from the scope device. The other PicoScope settings, the type of scope device [82] and the speed of the computer will all affect whether this limit can actually be reached. PicoScope automatically selects the appropriate limit according to whether your computer is running on batteries or on mains (line) power.


Preferences
General
Performance
OK
Cancel
Apply
Help
Capture rate limits
Mains power
Battery power
Current power mode:
Mains
Unlimited
Reducing the number of data frames per second that the scope captures will reduce the load on your PC. This can help other applications to run faster and will help to conserve battery life on a portable device.

The settings are in captures per second. By default, the capture rate is set to "Unlimited" when your computer is running on Mains (AC) power, for maximum performance. If other applications run too slowly on your PC whilst PicoScope is capturing, then reduce the capture rate limit. When your computer is running on Battery power, PicoScope imposes a performance limit to save the battery. You can increase this limit manually, but this will cause the battery power to drain very quickly.

Where to find it

Click the Preferences command in the Tools menu [32] on the Menu bar [21].

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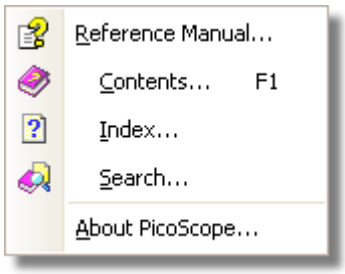
6.6 Help menu

Click Help on the Menu bar 21.



Reference Manual. This is the main help manual, containing information on every menu item, button and dialog in the program. Contents, Index and Search are shortcuts to the functions of the same names that can be found in the help window.

About PicoScope... Shows information about this version of PicoScope.

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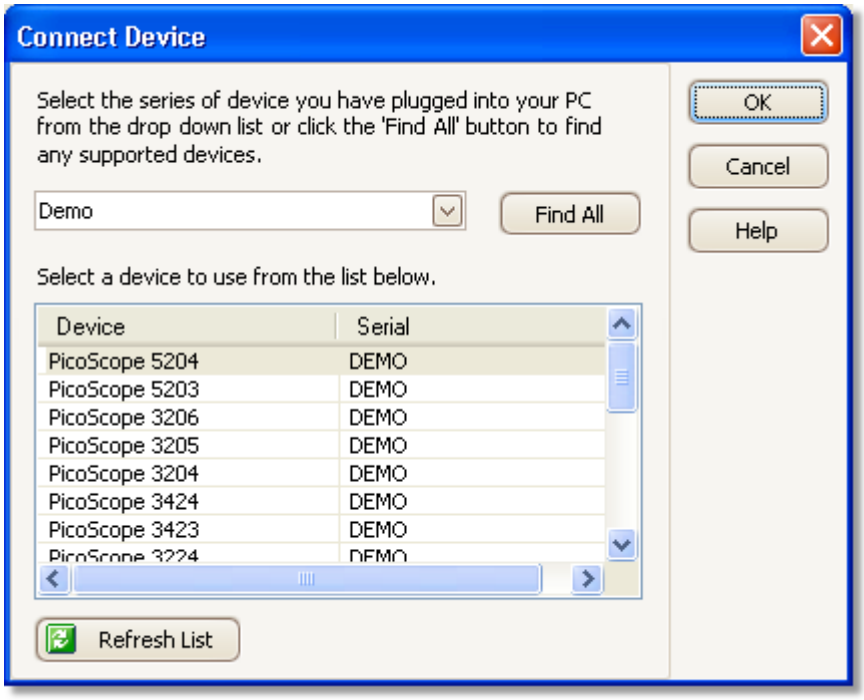
6.7 Connect Device dialog

When PicoScope is not sure which scope device 82 to use, it displays a list of all the units attached to your computer and allows you to select which one to use.



Where to find it

Select the File menu 22 and then the Connect Device command.

See "How to change to a different scope device 70" if you wish to switch to a different scope device later.

Procedure

- To restrict the selection to a particular series of devices, click on the device drop-down box and select a device series; otherwise, click the Find All button.
- Wait for a list of devices to appear in the grid.
- Select one device and click the OK button.
- PicoScope will open a scope view 13 for the selected scope device.
- Use the toolbars 49 to set up the scope device 82 and the scope view 13 or spectrum view 14 to display your signals.

Demonstration mode

If you start PicoScope with no scope device 82 connected, the Connect Device dialog automatically appears and contains a list of Demonstration devices for you to choose from. Once you have selected a demonstration device and clicked OK, PicoScope adds a Demo Signals toolbar 67 to the main window. Use this toolbar to set up the test signals from your demonstration device.

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7 Toolbars

A toolbar is a collection of buttons and controls with related functions. The Measurements toolbar 52, for example, looks like this:

- Buffer Navigation toolbar 50
- Channel Setup toolbar 50
- Demonstration Signals toolbar 67
- Measurements toolbar 52
- Capture Setup toolbar 53
- Signal Generator toolbar 56
- Start / Stop toolbar 59
- Triggering Toolbar 60
- Zooming and Scrolling toolbar 66

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7.1 Buffer Navigation toolbar

The Buffer Navigation toolbar allows you to select one waveform from the buffer of stored waveforms.

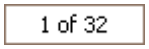
The waveform buffer

When you click the Start 59 button or change a capture setting 53, PicoScope clears the waveform buffer and then adds a new waveform to it every time the scope device captures data. This continues until the buffer is full or you click the Stop button. 59

You can review the waveforms stored in the buffer using these buttons:

First waveform button. Displays waveform 1.

Previous waveform button. Displays the previous waveform in the buffer.



Waveform number indicator. Shows which waveform is currently displayed, and how many waveforms the buffer holds. You can edit the number in the box and press Enter, and PicoScope will jump to the specified waveform.

Next waveform button. Displays the next waveform in the buffer.

Last waveform button. Displays the last waveform in the buffer.

7.2 Channel Setup toolbar

The Channel Setup toolbar controls the settings for each vertical input channel 81. The screen shot below shows the toolbar for a four-channel scope device 82, but different scope devices may have different numbers of channels.

Each channel has its own set of buttons:

Scale Control. Determines the maximum and minimum signal levels at the top and bottom of the Y axis for this channel. The number of options depends on the selected scope device 82 and probe 82. If you select Auto, PicoScope will continually adjust the vertical scale so that the height of the waveform fills as much of the view as possible.

Coupling Control. Selects AC coupling 81 or DC coupling 82.

Advanced Options button. Opens the Advanced Options menu 51 with options for probes 82 and scaling. 51

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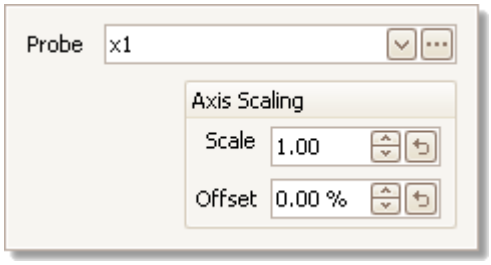
7.2.1 Advanced Options menu

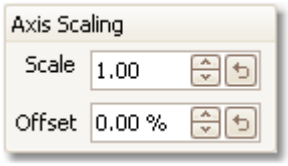
The Advanced Options menu appears when you click the Advanced Options button on the Channels toolbar 50.



Probe list. Indicates the probe currently in use and and allows you to select a different one. Use it to tell PicoScope what type of probe is connected to a channel. By default, the probe is assumed to be x1, which means that a one-volt signal at the input to the probe will appear as one volt on the display.

Expand probe list. Click this to select from a list of probes.

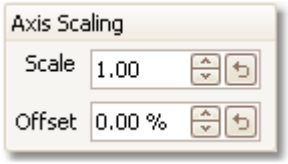
Open Custom Probes dialog. The Custom Probes dialog 32 allows you to edit your library of custom probes.



These are the axis scaling controls 51.

7.2.1.1 Axis scaling controls

The axis scaling controls let you change the scale and offset of each vertical axis independently.



There are two ways to obtain these controls: -

- Click the axis scaling button (x1.0) at the bottom of a vertical axis in a view
- Click the probe drop-down menu 51

Scale control. Increase to magnify the waveform, decrease to reduce it. The vertical axis rescales accordingly so that you can always read the correct voltage from the axis. Click the reset button ( ) to return to a scale of 1.0.

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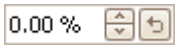
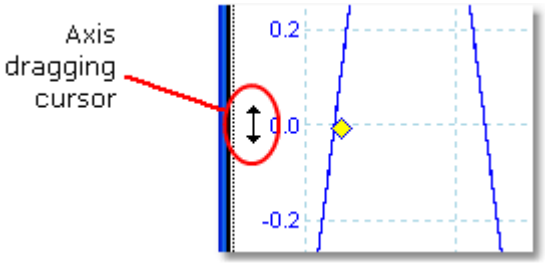


Offset control. Increase to move the waveform up the display, decrease to move it down. The vertical axis shifts accordingly so that you can always read the correct voltage from the axis. Adjusting this control is equivalent to clicking and dragging the vertical axis. Click the reset button ( ) to return to an offset of 0.00%.



7.3 Measurements toolbar

The Measurements toolbar controls the measurements table 11.

It contains the following buttons:

Add Measurement.	Adds a row to the table, and then opens the Add Measurement dialog. 31
Edit Measurement.	Opens the Edit Measurement dialog 31 for the currently selected measurement. You can also edit a measurement by double-clicking on a row of the measurements table. 11
Delete Measurement.	Deletes the currently selected row from the measurements table 11. If you delete the last measurement, the table disappears.

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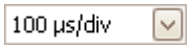
7.4 Capture Setup toolbar

The Capture Setup toolbar controls the time-related settings of your oscilloscope. It looks like this:

Auto Setup button. Searches for a signal on one of the enabled input channels, then sets up the timebase and signal range to display the signal correctly.



Timebase control. When the active view is a scope view, 13 this sets the time represented by a single division of the horizontal axis when the zoom 66 factor is 100%. The timebases available depend on the type of scope device 82 you are using.

Choosing a timebase of 200 ms/div or slower causes PicoScope to switch to a different mode of data transfer. The internal details of this are taken care of by PicoScope, but the slow mode limits the sampling rate to a maximum of 1 million samples per second.

Samples control. Sets the maximum number of samples that will be captured. If this is larger than the number of pixels across the scope view, then you can zoom in to see more detail. The actual number of samples captured is displayed on the Properties sheet, 15 and may be different from the number requested here, depending on which timebase is selected.

Spectrum Options button. Appears if a spectrum view 14 is open. It opens the Spectrum Options dialog. 54

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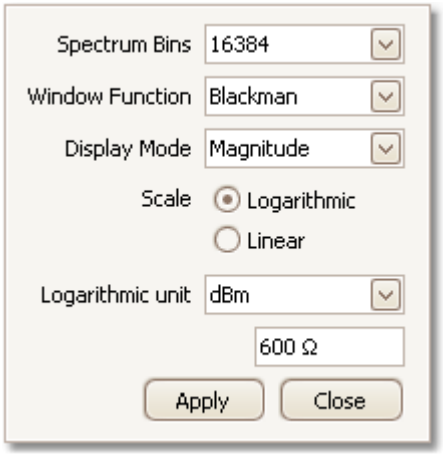
7.4.1 Spectrum Options dialog

This dialog appears when you click the Spectrum Options button in the Capture Setup toolbar. 53 It is available only when a spectrum view 14 is open. It contains controls that determine how PicoScope converts the source waveform in the current scope view to a spectrum view.



Spectrum Bins The number of frequency bins into which the spectrum is divided. This control sets the maximum number of frequency bins, which the software may or may not be able to provide depending on other settings. The main constraint is that the number of bins cannot exceed half the number of samples in the source waveform.

If the source waveform contains fewer samples than required (that is, fewer than twice the number of frequency bins), then PicoScope zero-pads the waveform up to the next power of two. For example, if the scope view contains 10,000 samples, and you set Spectrum Bins to 16384, then PicoScope zero-pads the waveform to 16,384 samples, which is the nearest power of two above 10,000. It then uses these 16,384 samples to provide 8,192 frequency bins, which is fewer than the 16,384 requested.

If the source waveform contains more samples than required, then PicoScope uses as many samples as necessary, starting from the beginning of the waveform buffer. For example, if the source waveform contains 100,000 samples and you request 16,384 frequency bins, PicoScope needs only 2 x 16,384 = 32,768 samples, so it uses the first 32,768 samples from the waveform buffer and ignores the rest.

Window Function Allows you to choose one of the standard window functions to reduce the effect of operating on a time-limited waveform. See Window functions. 78

Display Mode You can choose Magnitude, Average or Peak Hold.

Magnitude: the spectrum view shows the frequency spectrum of the last waveform captured, whether live or stored in the waveform buffer. 50

Average: the spectrum view shows an rolling average of spectra calculated from all the waveforms in the waveform buffer 50. This has the effect of reducing the noise visible in the spectrum view. To clear the averaged data, click Stop 59 and then Start. 59 or change from Average mode to Magnitude mode.

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Peak Hold: the spectrum view shows a rolling maximum of the spectra calculated from all the waveforms in the buffer. In this mode, the amplitude of any frequency band in the spectrum view will either stay the same or increase, but never decrease, over time. To clear the peak hold data, click Stop 59 and then Start. 59 or change from Peak Hold mode to Magnitude mode.

Note: when you switch to Average or Peak Hold mode, there may be a noticeable delay while PicoScope processes the entire contents of the waveform buffer, which may contain many waveforms, to build up the initial display. If this occurs, a progress bar appears at the bottom of the screen to show that PicoScope is busy:

Scale — Specifies the labelling and scaling of the vertical (signal) axis. This can be one of the following:

Linear: — The vertical axis is calibrated in volts.

Logarithmic: — The vertical axis is calibrated in decibels, referred to the level selected below in the Logarithmic unit control.

- dBV: — Reference level is 1 volt.
- dBu: — Reference level is 1 milliwatt with a load resistance of 600 ohms.
- dBm: — Reference level is one milliwatt. You can enter the load impedance for this calculation in the text box below the Logarithmic unit control.
- Arbitrary dB: — Reference level is an arbitrary voltage, which you can specify in the box below the Logarithmic unit control.

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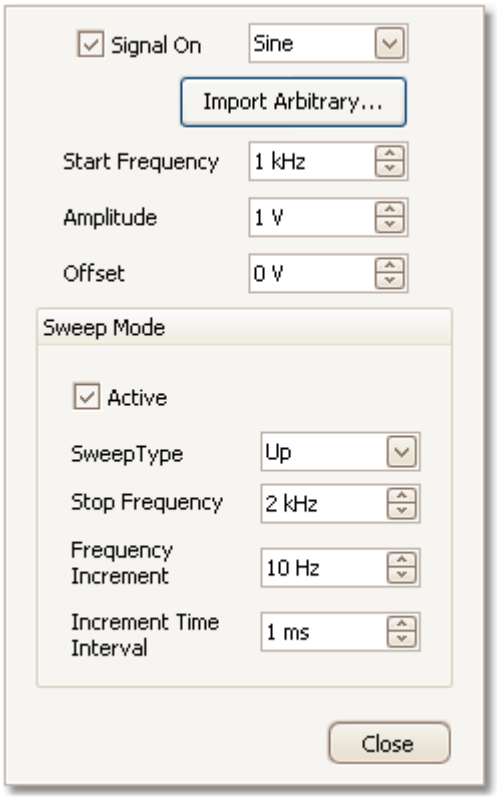
7.5 Signal Generator toolbar

The Signal Generator toolbar allows you to set up your scope device 82's test signal output. This toolbar appears only when you are using a scope device with a built-in signal generator.

Clicking the Signal Generator button opens the Signal Generator dialog 56.

7.5.1 Signal Generator dialog

This dialog controls the scope device's 82 built-in signal generator. It is not available if the selected scope device does not have a signal generator. The number of controls in the dialog may vary according to the type of scope device in use.



Signal generator dialog for the PicoScope 5204

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How to use it

Signal On. Tick this box to enable the signal generator.

Frequency. Type in this box or use the spin buttons to select the frequency. If the scope device has a frequency sweep generator, then this box will set the start frequency of the sweep.

Signal Type. Select the type of signal to be generated.

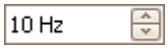
Import Arbitrary. For scope units that support arbitrary waveforms, click to import an arbitrary waveform file. 58

Sweep Mode Active. Tick this box to enable sweep mode. Otherwise, the generator will operate at a fixed frequency set by the Start Frequency box.

Repeat Signal. Tick this box to generate a repetitive sweep. Otherwise, the generator will reach Stop Frequency and then remain there.

Dual Slope. In normal mode, the generator will increase the frequency linearly from Start Frequency to Stop Frequency, and then immediately begin again at Start Frequency. In Dual Slope mode, it will reach Stop Frequency and then decrease the frequency linearly to Start Frequency before beginning again.

Stop Frequency. In Sweep Mode, the generator will stop increasing the frequency when it reaches Stop Frequency.



Frequency Increment. In Sweep Mode, the generator will increase or decrease the frequency by this amount every Increment Time Interval.

Increment Time Interval. In Sweep Mode, the generator will increase or decrease the frequency by Frequency Increment once every time interval of this duration.

Where to find it

Click the Signal Generator button 56 on the toolbar.

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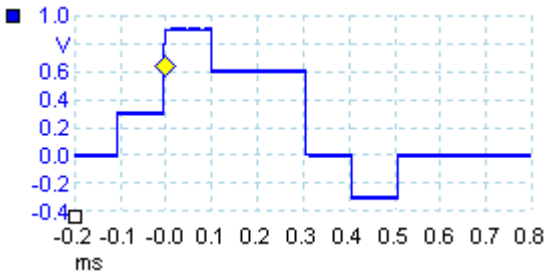
7.5.2 Arbitrary waveform files

Some PicoScope PC Oscilloscopes, such as the PicoScope 5203 and PicoScope 5204, have an arbitrary waveform generator (81) (AWG). PicoScope can program this with a standard waveform, such as a sine or a square wave, or can import an arbitrary waveform from a text file.

A text file for PicoScope 6 is a simple list of decimal floating-point values, as in this example:

```
0.0
0.3
0.9
0.6
0.6
0.0
-0.3
0.0
0.0
0.0
```

→



The file may have between 10 and 8,192 values, as many it needs to define the waveform. Each line may have more than one value, in which case the values must be separated by tabs or commas.

The values are samples between –1.0 and +1.0 and must be equally spaced in time. The output is scaled to the amplitude selected in the Signal Generator dialog, (56) and the selected offset is added if necessary. For example, if the signal generator amplitude is set to "1 V", then a sample value of -1.0 corresponds to an output of -1.0 V and a sample of +1.0 corresponds to an output of +1.0 V.

The file should contain exactly one cycle of the waveform, which will then be played back at the speed specified in the Signal Generator dialog (56). In the example above, the signal generator was set to 1 kHz, so one cycle of the waveform lasts for 1 ms. There are 10 samples in the waveform, so each sample lasts for 0.1 ms.

Using files saved from PicoScope 6

As PicoScope 6 can export CSV and TXT files, (24) you can capture a waveform and then play it back using the arbitrary waveform generator. You must first modify the file by removing the header rows and time values, so that its format matches the example above.

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7.6 Start / Stop toolbar

The Start / Stop toolbar allows you to start and stop the scope device 82. The Start button is highlighted if the scope device is sampling; otherwise, the Stop button is highlighted.

Start button. Start sampling.

Stop button. Click to stop sampling.

You can also use the space bar to start and stop sampling.

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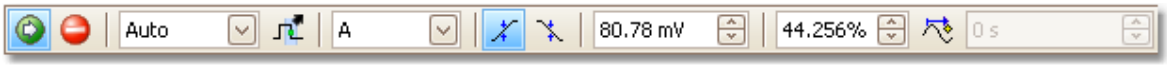
7.7 Triggering toolbar

The Triggering toolbar tells the scope device when to start capturing data.



Trigger Mode.

None: PicoScope acquires waveforms repeatedly without waiting for specific events.

Auto: PicoScope tries to wait for a trigger event before displaying data. If there is no trigger event within a specified time, it displays data anyway. It repeats this process until you click the Stop button 59. "Auto" mode does not set up the trigger level automatically; you still need to do this yourself.

Repeat: PicoScope waits for a trigger event before displaying data; but if there is no trigger event, it displays nothing. It repeats this process until you click the Stop button 59.

Single: PicoScope waits once for a trigger event, then stops sampling. To repeat a single trigger, click the Start 59 button.

ETS: Equivalent Time Sampling. 82 The scope view 13 captures several cycles of a repetitive signal, then combines the results to produce a single waveform with higher time-resolution than a single capture. For accurate results, the signal must be perfectly repetitive and the trigger must be stable.

If you select ETS when an Advanced Trigger 62 type is enabled, the trigger type will revert to Simple Edge and the Advanced Triggering button will be disabled.

Advanced Triggering. Click to open the Advanced Triggering dialog. 62 which gives you extra trigger types beyond the simple edge trigger. If this button is disabled, it is because you have selected either None or ETS in the trigger mode control. If you want to enable the Advanced Triggering button, set the control to another trigger mode, such as Auto, Repeat or Single.

Trigger Source. This is the channel that PicoScope monitors for the trigger 82 condition.

Rising Edge. Click to trigger on the rising edge of the waveform.

Falling Edge. Click to trigger on the falling edge of the waveform.

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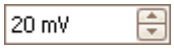
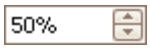


Trigger Level. Sets the trigger 82 level. You can also set the trigger level by dragging the trigger marker 18 up or down on the screen.



Pre-trigger Time (0% to 100%). This parameter controls how much of the waveform appears before the trigger point. It defaults to 50%, which puts the trigger marker 18 is in the middle of the screen. You can also control this parameter by dragging the trigger marker 18 to the left or right.

Post-trigger Delay Enable. Click this button to toggle the Post-trigger Delay control (see next item).

Post-trigger Delay. The post-trigger delay is the time that PicoScope waits after the trigger point before sampling. You can also modify this parameter by dragging the trigger marker 18 while the Post-trigger Delay button is enabled. As you drag the marker, you will see the post-trigger arrow 12 displayed briefly. For this control to have an effect, you must first make sure that the Post-trigger Delay button is enabled.

See the reference topic "Trigger Timing 79" for information on how the Pre-trigger Time and Post-trigger Delay controls interact.

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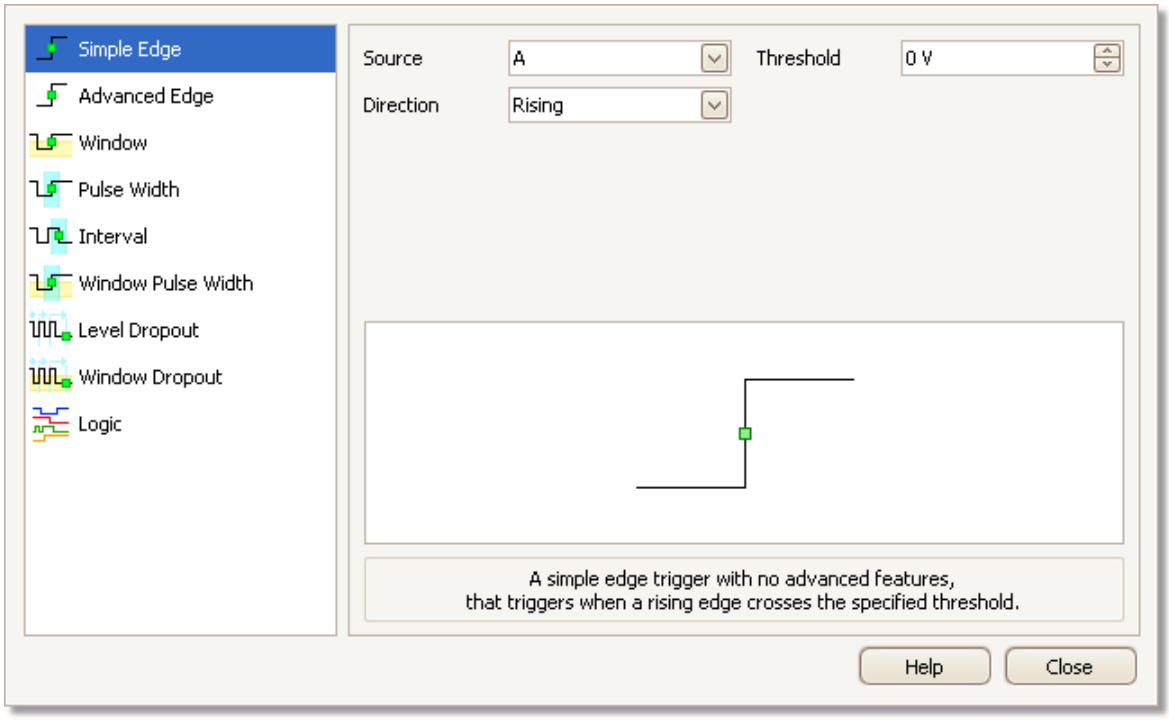
7.7.1 Advanced Triggering dialog

This dialog appears when you click the Advanced Triggering button in the Triggering toolbar. 60 It allows you to set up more complex trigger types than simple edge-triggering.



Advanced trigger types list. This control lists all the available advanced trigger types. 63 Click on the condition you require, and a diagram and description will appear on the right of the dialog.

If ETS triggering 82 is enabled in the triggering toolbar 60, then selecting any trigger type except Simple Edge switches off ETS mode.

Advanced triggering options. The options available depend on the trigger type selected. See Advanced trigger types. 63 Instructions and diagrams also appear in the dialog.

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7.7.2 Advanced trigger types

The advanced trigger types can be switched on in the Advanced Triggering dialog. 62

For all trigger types, the first step is to select which signal the scope should use as the trigger; so set Source to either A, B, Ext or AuxIO. These names correspond to the BNC input connectors on the scope device. Then choose one of the trigger types below.

Simple Edge. This type provides the same Rising and Falling edge triggers that are available from the Triggering toolbar. 60 It is included in this dialog as an alternative method of setting up the Simple Edge trigger.

You can set the trigger Threshold while in the advanced triggering dialog, or alternatively you can drag the Trigger marker 18 on the scope view.

This is the only trigger type that is compatible with ETS 82 mode.

Advanced Edge. This trigger type adds an extra Rising or Falling edge trigger, and Hysteresis, to the Simple Edge trigger. The Rising or Falling option triggers on both edges of a waveform, and is useful for monitoring pulses of both polarities at once. Hysteresis 65 is described in a separate topic.

Window. This trigger type detects when the signal enters or leaves a specified voltage window. The Direction control specifies whether the trigger should detect the signal entering the window, leaving it, or both. Threshold 1 and Threshold 2 are the upper and lower voltage limits of the window. The order in which you specify the two voltages does not matter. Hysteresis 65 can be set to reduce the number of false triggers on a noisy signal, and is described in a separate topic.

Pulse Width. This trigger type detects pulses of a specified width.

First set the Pulse Direction to either Positive or Negative according to the polarity of the pulse you are interested in.

Next, set one of the four Condition options:

Greater than triggers on pulses wider than the specified time.

Less than triggers on pulses that are narrower (useful for finding glitches).

Inside time range triggers on pulses that are wider than Time 1 but no wider than Time 2 (useful for finding pulses that meet a specification).

Outside time range does the opposite: it triggers on pulses that are either narrower than Time 1 or wider than Time 2 (useful for finding pulses that violate a specification).

Next, set the trigger Threshold in volts or other units, or drag the Trigger marker 18 on the scope view.

Finally, set up Time 1 (and Time 2 if present) to define the pulse width.

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Interval. This type lets you search for two successive edges of the same polarity that are separated by a specified interval of time.

First, set the Starting edge to either Rising or Falling according to the polarity of the edges you are interested in.

Next, select one of the four Condition options:

Greater than triggers when the second edge occurs later than Time 1 after the first edge (useful for detecting missing events).

Less than triggers when the second edge occurs earlier than Time 1 after the first edge (useful for detecting timing violations and spurious edges).

Inside time range triggers when the second edge is later than Time 1 after the first edge and earlier than Time 2 (useful for finding valid edges).

Outside time range triggers when the second edge is earlier than Time 1 after the first edge or later than Time 2 (useful for finding spurious edges).

Finally, set up Time 1 (and Time 2 if present) to define the time interval.

Window pulse width. This is a combination of the window trigger and the pulse width trigger. It detects when the signal enters or leaves a voltage range for a specified period of time.

Level dropout. This detects an edge followed by a specified time with no edges. It is useful for triggering on the end of a pulse train.

Window dropout. This is a combination of the window trigger and the dropout trigger. It detects when the signal enters a specified voltage range and stays there for a specified time. This is useful for detecting when a signal gets stuck at a particular voltage.

Logic. This can detect a number of logical combinations of the scope's four inputs: A, B, Ext and AUXIO. The conditions that can be applied to each input vary: A and B can be edge-, level- or window-qualified; Ext is level-qualified with a variable threshold; and AUXIO is level-qualified with a fixed TTL threshold.

You can choose to combine the channels with an AND, NAND, OR, NOR, XOR or XNOR function.

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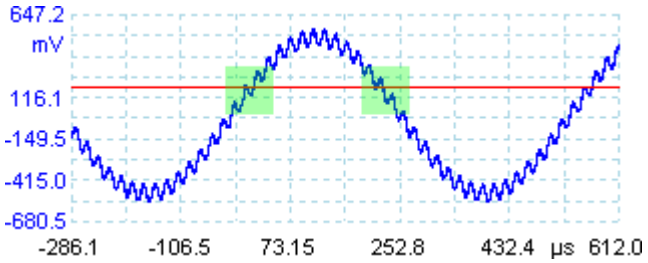
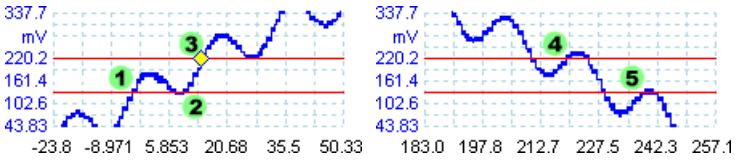
7.7.2.1 Hysteresis

Hysteresis is a feature of the advanced trigger types 63 in PicoScope 6 that reduces false triggering on noisy signals. When hysteresis is enabled, a second trigger threshold voltage is used in addition to the main trigger threshold. The trigger fires only when the signal crosses the two thresholds in the correct order. The first threshold arms the trigger, and the second causes it to fire. An example will help to illustrate how this works.



Noisy signal with a single threshold

Consider the very noisy signal above. It is difficult to trigger reliably on this signal with a normal rising edge trigger because it crosses the trigger threshold, the red line in this picture, several times in one cycle. If we zoom in on the highlighted parts of the signal, we will see how hysteresis can help.



Noisy signal with hysteresis threshold

In these zoomed-in views, the original threshold is the lower red line. The upper red line is the second threshold used by the hysteresis trigger.

The signal rises across the lower threshold at (1) and (2), arming the trigger but not firing it. At (3) the signal finally crosses the upper threshold, firing the trigger. On the falling edge of the signal, at (4) and (5), rising edges of noise pulses cause the signal to cross the upper and lower thresholds, but in the wrong order, so the trigger is not armed and does not fire. Thus the trigger occurs at only one well-defined point in the cycle (3), despite the noise on the signal.

Hysteresis is enabled by default for all the advanced trigger types. The Hysteresis controls in the Advanced triggering dialog 62 let you change the hysteresis voltage as a percentage of full scale. The trigger marker shows the size of the hysteresis window.

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7.8 Zooming and Scrolling toolbar

The Zooming and Scrolling toolbar allows you to move around a scope view 13 or spectrum view. 14 Each button has a keyboard shortcut, which is listed in the table.

	Ctrl+S or Esc	Normal Selection tool. This button turns the pointer into a standard arrow that you can use to click buttons, drag rulers 82 and operate any other controls that appear in the PicoScope window.
	Ctrl+D	Hand tool. This button turns the pointer into a hand tool that you can use to click and drag the view to pan it vertically and horizontally when you are zoomed in. You can also pan using the scroll bars. Press the Esc key to return to the Normal Selection tool.
	Ctrl+I	Zoom In tool. This button turns the pointer into a zoom-in tool. Click the tool on the view to double the magnification of the horizontal and vertical axes. Scroll bars will appear, which you can drag to pan around the view, or you can pan by using the Hand tool (see above). Press the Esc key to return to the Normal Selection tool.
	Ctrl+O	Zoom Out tool. This button turns the pointer into a zoom-out tool. Click the tool on the view to zoom out both horizontally and vertically by a factor of two. You cannot zoom out beyond 100% (normal size). Press the Esc key to return to the Normal Selection tool.
	Ctrl+M	Marquee Zoom tool. This button turns the pointer into a marquee zoom tool. Use it to draw a box called a marquee on the view and PicoScope will magnify that box to fill the view. Scroll bars will appear, which you can drag to pan around in the view, or you can pan by using the Hand tool (see above). Press the Esc key to return to the Normal Selection tool.
	Ctrl+U	Zoom to full view. Resets the view to normal size. The view will no longer have scroll bars, and panning will no longer be possible.

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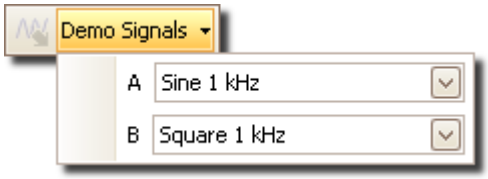
7.9 Demonstration Signals toolbar

The Demonstration Signals toolbar allows you to set up test signals so that you can experiment with PicoScope when no scope device is connected. To use this feature, close PicoScope, unplug all scope devices and then restart the program. PicoScope will prompt you to select a demonstration device using the Connect Device dialog 48.

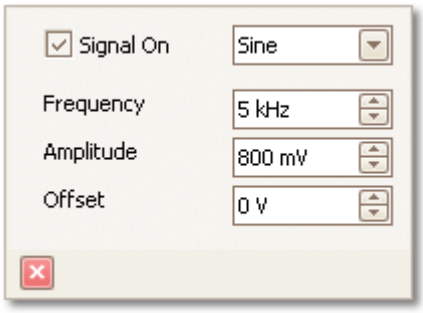
When you click the button, a drop-down list of all the available channels in your demonstration device will appear, like this:



Click one of the channels to open the Demonstration Signals dialog, 67 which will allow you to set up a signal from that channel.

7.9.1 Demonstration Signals dialog

This dialog controls one channel of the demonstration signal generator, a feature of PicoScope that creates a variety of test signals to simulate a scope device. Open it by clicking the Demo Signals button on the Demonstration Signals toolbar 67 and then selecting a channel. It is available only when you start PicoScope with no scope device 82 connected to your computer, and then select a scope device type of "Demo" in the Connect Device dialog 48.



Signal On: Tick this box to enable the demonstration signal generator.

Frequency: Type your desired frequency in hertz here, or use the spin buttons.

Amplitude: Type your desired amplitude in millivolts here, or use the spin buttons.

Offset: Enter a number here to add a d.c. offset to the demo signal. By default, the demo signals have a mean value of zero volts.

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Where to find it

Click the Demo Signals button on the Demonstration Signals toolbar. 67 You must have previously selected a "Demo" scope device 82 type in the Connect Device dialog. 48

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8 How to...

This chapter explains how to achieve some common tasks.

How to...

- Change to a different scope device 70
- Use rulers to measure a signal 70
- Measure a time difference 71
- Move a view 72
- How to set up the spectrum view 74

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8.1 How to change to a different scope device

- Close PicoScope
- Unplug the old scope device 82
- Plug in the new scope device
- Restart PicoScope

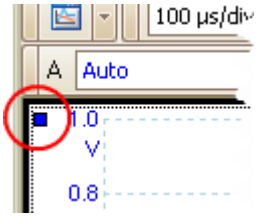
PicoScope will detect that the scope device has changed and will immediately start using the new scope device. If there is more than one scope device connected, the Connect Device dialog 48 will appear to let you choose a scope.

8.2 How to use rulers to measure a signal

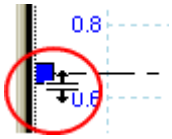
Using a single ruler for signal-to-ground measurements

- Look at the Channels toolbar 50 to find the colour code for the channel 81 you wish to measure:

- Find the ruler handle (the small coloured square in the top-left or top-right corner of the scope view 13 or spectrum view 14) of this colour:



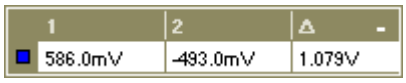
- Drag the ruler handle downwards. A signal ruler 19 (horizontal broken line) will appear across the view. Release the ruler handle when the ruler is where you want it.



- Look at the ruler legend 12 (the small table that appears on the view). It should have a row marked by a small coloured square matching the colour of your ruler handle. The first column shows the signal level of the ruler.

Using two rulers for differential measurements

- Follow the steps above for "using a single ruler".
- Drag the second ruler handle of the same colour downwards until its ruler is at the signal level to be measured.
- Look at the ruler legend 12 again. The second column now shows the signal level of the second ruler, and the third column shows the difference between the two rulers.



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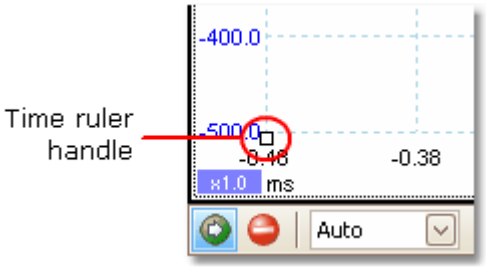
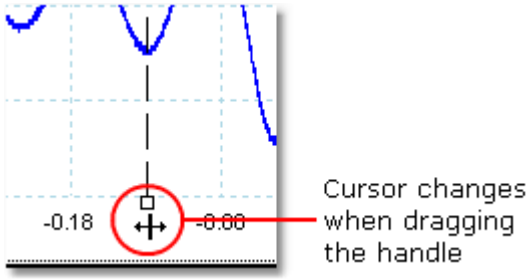
8.3 How to measure a time difference

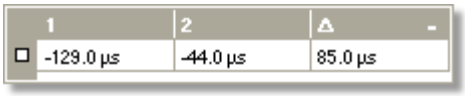
- Find the time ruler handle (the small white square in the bottom left corner of the scope view 13).



- Drag the ruler handle to the right. A time ruler 17 (vertical broken line) will appear on the scope view. Release the ruler handle when the ruler is at the time you wish to use as the reference.



- Drag the second white ruler handle to the right until its ruler is at the time to be measured.
- Look at the ruler legend 12 (the small table that appears on the scope view). It should have a row marked by a small white square. The first two columns show the times of the two rulers, and the third column shows the time difference.



- The frequency legend 11 shows 1/Δ, where Δ is the time difference.

You can use a similar method to measure a frequency difference on a spectrum view. 14

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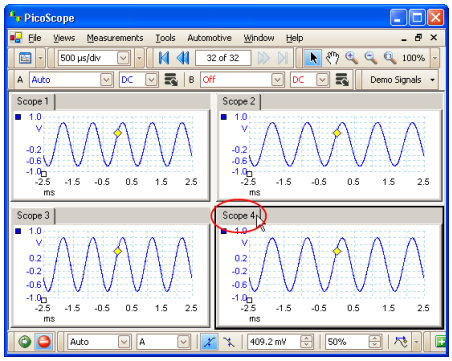
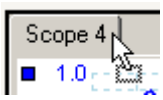
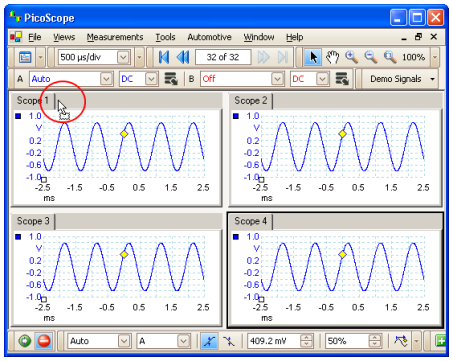
8.4 How to move a view

You can easily drag a view 19 from one viewport 82 to another. This example shows four viewports. The viewports contain scope views 13 or spectrum views 14 called "Scope 1" to "Scope 4". Suppose you wish to move the "Scope 4" view to the top left viewport.

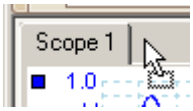


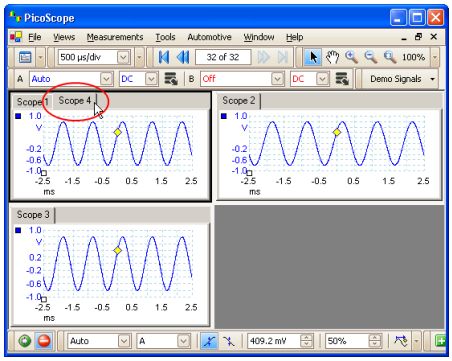
1. Click on the name tab of the "Scope 4" view and hold the mouse button down.



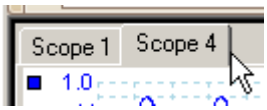


2. Drag the mouse pointer to the new location next to the name tab of the "Scope 1" view.





3. Release the mouse button, and the view will move to the new location.



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8.5 How to scale and offset a signal

PicoScope offers three ways to change the size and position of a signal during or after capture. These methods apply equally to scope views 13 and spectrum views. 14

Use global zooming and scrolling

To move all signals at once, use the global zoom and pan controls on the zooming and scrolling toolbar. 66

This is usually the quickest way to put your signals where you want them. When a view is zoomed in, it has vertical and horizontal scroll bars that let you move the signals around as a group. You can also use the hand tool.

Use axis scaling and offset

Use this method when you want to apply an accurate scale and offset to only one channel.

Click the scaling indicator 51 x1.0 at the bottom of the axis you wish to modify, and the axis scaling controls 51 will appear. To adjust the offset without using the axis scaling controls, click on the vertical axis and drag it up or down.

Define a custom probe

This is the most complex method, but saves time if you use a particular scope probe frequently. You only need to set it up once for each probe, and you can then easily retrieve it whenever you use that probe. See the Custom probe 32 topic for details.

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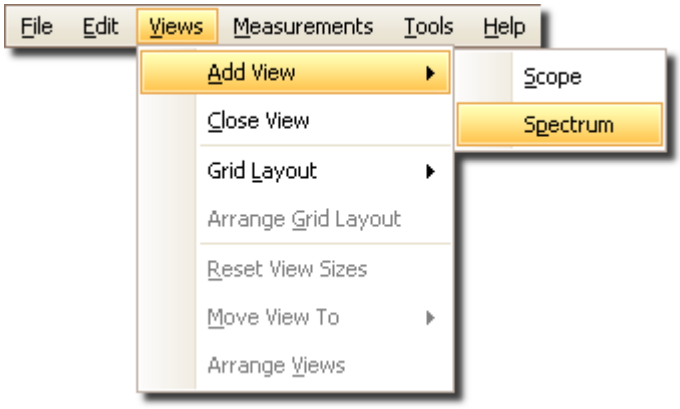
8.6 How to set up the spectrum view

Creating a spectrum view

First, ensure that the trigger mode 60 is not set to ETS, 82 as it is not possible to open a spectrum view in ETS trigger mode.

There are two ways to open a spectrum view: 14

- Go to the Views menu 29 select Add view, then select Spectrum.



- Right-click on any view 13, select Add view, then select Spectrum. The menu is similar to the Views menu 29 shown above.

Configuring the spectrum view

See Spectrum Settings dialog. 54

Selecting the source data

PicoScope can produce a spectrum view 14 based on either live or stored data. If PicoScope is running (the Start 59 button is pressed in), the spectrum view represents live data. Otherwise, with PicoScope stopped (the Stop 59 button pressed in), the view represents data stored in the currently selected page of the waveform buffer. When PicoScope is stopped, you can use the buffer controls 50 to scroll through the buffer and the spectrum view will be recalculated from the waveform currently selected.

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9 Reference

This is where you can find detailed information on the operation of PicoScope.

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9.1 Measurement types

The Edit Measurement dialog 31 allows you to select one of a range of measurements that PicoScope can calculate for the selected view. The list of measurements available depends on whether the view is a scope view 13 (see scope measurements 75) or a spectrum view 14 (see spectrum measurements 76)

9.1.1 Scope measurements

AC RMS:	The root mean square (RMS) value of the AC component of the waveform. This measurement subtracts any DC offset from the waveform. It is equivalent to a *ripple* measurement.
Cycle Time:	PicoScope will attempt to find a repeated pattern in the waveform and measure the duration of one cycle.
DC Average:	The mean value of the waveform.
Duty Cycle:	The amount of time that a signal spends above its mean value, expressed as a percentage of the signal period. A duty cycle of 50% means that the high time is equal to the low time.
Falling Rate:	The rate at which the signal voltage falls, in signal units per second. Measured between 80% and 20% of its peak-to-peak value.
Fall Time:	The time the signal takes to fall from 80% to 20% of its peak values.
Frequency:	The number of cycles of the waveform per second.
High Pulse Width:	The amount of time that the signal spends above its mean value.
Low Pulse Width:	The amount of time that the signal spends below its mean value.
Maximum:	The highest level reached by the signal.
Minimum:	The lowest level reached by the signal.
Peak To Peak:	The difference between maximum and minimum.
Rise Time:	The time the signal takes to rise from 20% to 80% of its peak-to-peak value.
Rising Rate:	The rate at which the signal rises, in signal units per second. Measured between 20% and 80% of its peak-to-peak value.

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9.1.2 Spectrum measurements

Frequency at peak

The frequency at which the peak signal value appears.

Amplitude at peak

The amplitude of the peak signal value.

Total power

The power of the whole signal captured in the spectrum view.

Total power = sqrt(sum(value(n)^2)) for all n

Total Harmonic Distortion (THD)

The ratio of the harmonic power to the power at the specified frequency.

$$\mathrm{THD} = 20\log_{10}\left(\frac{\sqrt{V_2^{\,2} + V_3^{\,2} + V_4^{\,2} + V_5^{\,2} + \ldots}}{V_1}\right)$$

Total Harmonic Distortion plus Noise (THD+N)

The ratio of the harmonic power plus noise to the fundamental power. THD+N values are almost be greater than the THD values for the same signal.

$$\mathrm{THD+N} = 20\log_{10}\left(\frac{\sqrt{\text{sum of squares of RMS values excluding datum}}}{\text{RMS value of datum}}\right)$$

Spurious-free Dynamic Range (SFDR)

This is the ratio of the amplitude of the specified point (normally the peak frequency component) and the frequency component with the second largest amplitude (call it "SFDR frequency"). The component at the "SFDR frequency" is not necessarily a harmonic of the fundamental frequency component. For example, it might be a strong, independent noise signal.

Signal+Noise+Distortion to Signal+Noise Ratio (SINAD)

The ratio, in decibels, of the signal-plus-noise-plus-distortion to noise-plus-distortion.

$$\mathrm{SINAD} = 20\log_{10}\left(\frac{\text{RMS value of datum}}{\sqrt{\text{sum of squares of all RMS components except datum}}}\right)$$

Signal to Noise Ratio (SNR)

The ratio, in decibels, of the mean signal power to the mean noise power. Hanning or Blackman windows are recommended because of their low noise.

$$\mathrm{SINAD} = 20\log_{10}\left(\frac{\text{RMS value of datum}}{\sqrt{\text{sum of squares of all RMS components except datum}}}\right)$$

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Intermodulation Distortion (IMD)

A measure of the distortion caused by the nonlinear mixing of two tones. When multiple signals are injected into a device, modulation or nonlinear mixing of these two signals can occur. For input signals at frequencies f1 and f2, the two second-order distortion signals will be found at frequencies: f3 = (f1 + f2) and f4 = (f1 - f2).

IMD is expressed as the dB ratio of the RMS sum of the distortion terms to the RMS sum of the two input tones. IMD can be measured for distortion terms of any order, but the second-order terms are most commonly used. In the second-order case, the intermodulation distortion is given by:

$$\mathrm{IMD} = 20\log_{10}\sqrt{\frac{F_3^{\,2} + F_4^{\,2}}{F_1^{\,2} + F_2^{\,2}}}$$

where

F3 and F4 are the amplitudes of the two second-order distortion terms (at frequencies f3 and f4 defined above)

and

F1 and F2 are the amplitudes of the input tones (at frequencies f1 and f2, as marked by the frequency rulers in the spectrum window).

For reference, the third-order terms are at frequencies (2F1 + F2), (2F1 - F2), (F1 + 2F2) and (F1 - 2F2).

Note: Hanning or Blackman windows are recommended because of their low noise. An FFT size of 4096 or greater is recommended in order to provide adequate spectral resolution for the IMD measurements.

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9.2 Window functions

To create a spectrum view, 14 PicoScope uses a Fast Fourier Transform to compute the spectrum of a block of sampled data. A block of sampled data has a beginning and an end, and these sharp boundaries have an effect on the computed spectrum, creating unwanted artefacts such as ripple and gain errors. To reduce these artefacts, the signal can be smoothed so it tapers off to zero at the start and end of the block. A number of different types of smoothing, called window functions, can be applied depending on the type of signal and the purpose of the measurement. The rectangular window is simply the unsmoothed, truncated version of the data.

The Window Functions control in the Spectrum Options dialog 54 lets you select one of the standard window functions for spectrum analysis. The following table shows some of the figures of merit used to compare window functions.

Window	Main peak width (bins @ -3 dB)	Highest side lobe (dB)	Side lobe roll-off (dB/octave)	Notes
Blackman	1.68	-58	18	often used for audio work
Gaussian	1.33 to 1.79	-42 to -69	6	gives minimal time and frequency errors
Triangular	1.28	-27	12	also called Bartlett window
Hamming	1.30	-41.9	6	also called raised sine-squared; used in speech analysis
Hann	1.20 to 1.86	-23 to -47	12 to 30	also called sine-squared; used for audio & vibration
Blackman-Harris	1.90	-92	6	general-purpose
Flat-top	2.94	-44	6	negligible pass-band ripple; used mainly for calibration
Rectangular	0.89	-13.2	6	maximal sharpness; used for short transients

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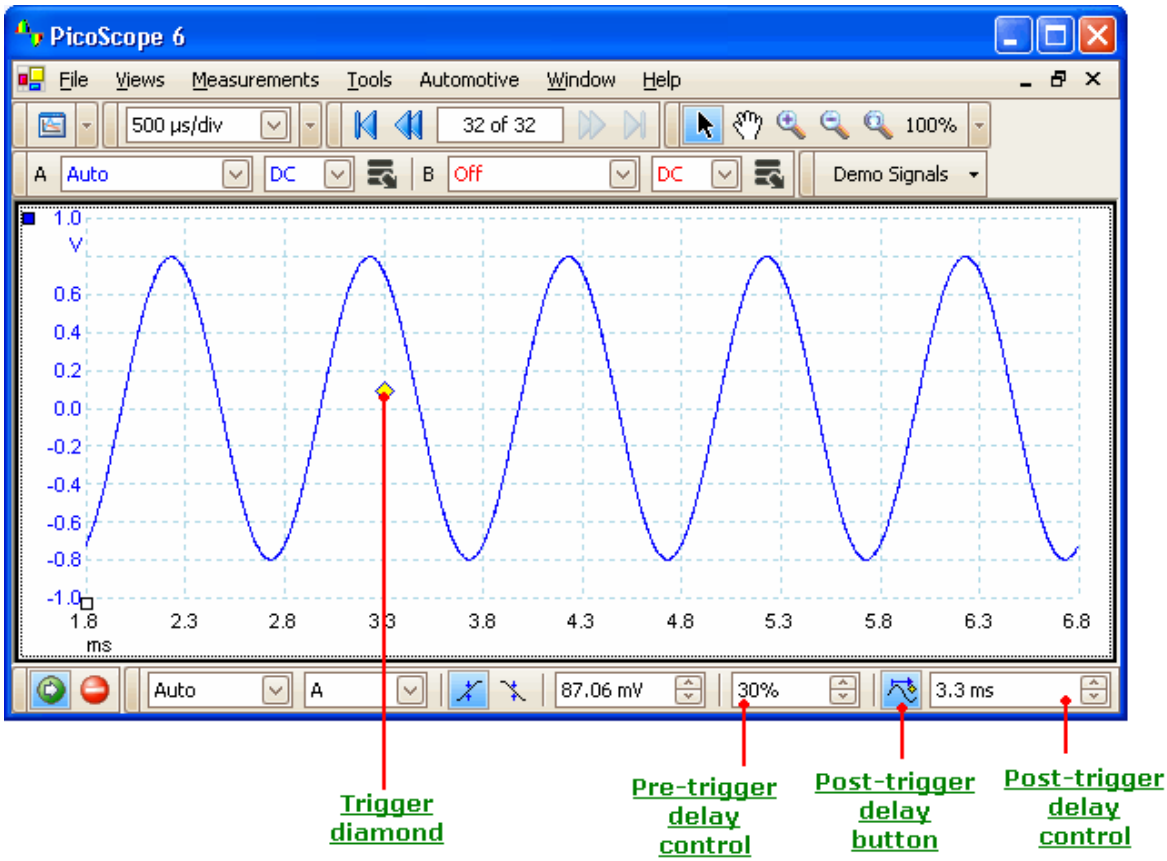
9.3 Trigger timing (part 1)

The pre-trigger time control and post-trigger delay control functions are described individually under "Triggering toolbar", 60 but the interaction between the two controls is also important to understand. Here is a screen shot of a scope view 13 with post-trigger delay enabled:



Note 1. The trigger reference point (◇) does not lie on the waveform. This is because the post-trigger delay is set to 3.3 ms, which means that the trigger occurred 3.3 ms before the reference point, somewhere off the left-hand edge of the scope view. 13 The time axis is aligned so that the trigger reference point is at 3.3 ms.

Note 2. The pre-trigger delay is set to 30%, which forces the trigger reference point to appear 30% of the way across the scope view from the left-hand edge.

Note 3. PicoScope limits the trigger-to-reference-point delay to a multiple of the total capture time. Once you have reached this limit, the program will not let you increase the pre-trigger delay, and if you increase the post-trigger delay, PicoScope will reduce the pre-trigger delay to stop the total exceeding the limit. The multiple is typically 100 in most trigger modes, and 1 in ETS 82 mode.

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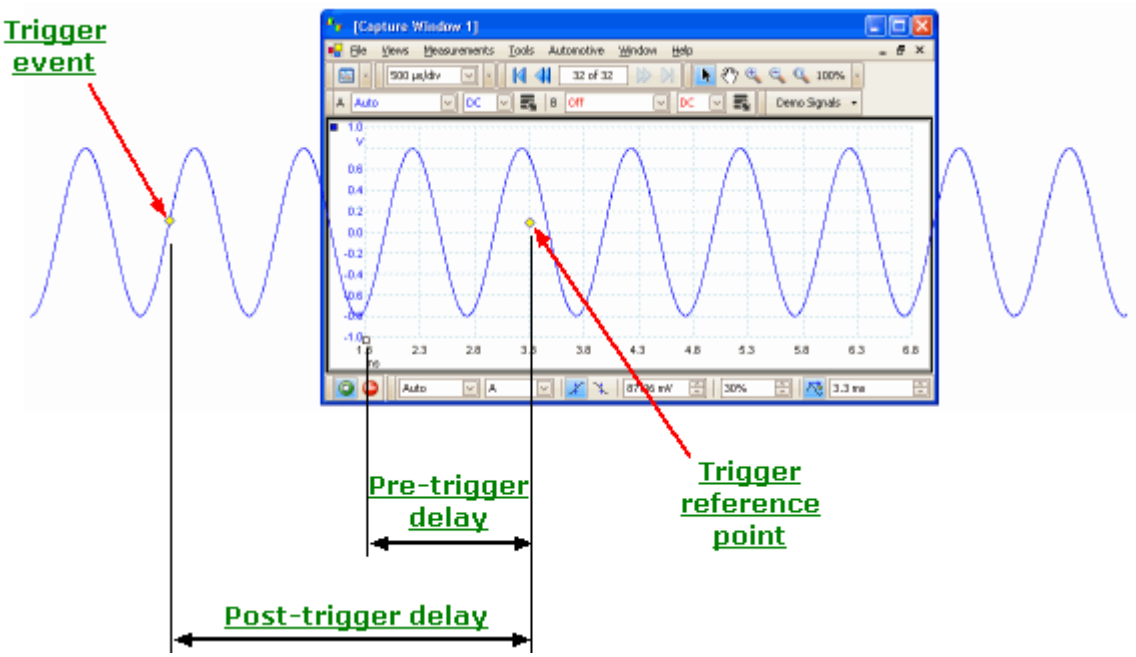
9.4 Trigger timing (part 2)

"Trigger timing (part 1) 79" introduced the concepts of pre-trigger delay 60 and the post-trigger delay 60. This diagram below shows how they are related.



The pre-trigger delay positions the scope view 13 in relation to the trigger reference point so that you can choose how much of the waveform should be before the reference point, and how much after it.

The post-trigger delay is like the delayed trigger of a conventional oscilloscope. PicoScope waits for this time, minus the pre-trigger delay, before capturing data. Scope devices have a limit to the number of sampling intervals that can elapse between the trigger event and the end of the window, so the software may adjust the pre-trigger delay to keep within this limit.

Tip

If you have set up a post-trigger delay, you can click the post-trigger delay button while the scope is running whenever you want to switch between viewing the trigger event and the trigger reference point.

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9.5 Keyboard shortcuts

You can activate most of PicoScope's functions using the menu system, but some functions also have keyboard shortcuts. These can save time on tasks that you repeat often.

Ctrl-C	Copy the current view to the Windows clipboard. You can then switch to another application and paste the contents of the clipboard as a picture. The method for doing this varies, but many applications use the Ctrl-V key or a "Paste" button.
Ctrl-D	Hand tool. Use to pan the waveform when zoomed in. Equivalent to the "Hand tool" button on the Zooming and Scrolling toolbar. 66
Ctrl-I	Zoom-in tool. Click on the waveform to zoom in. Equivalent to the "Zoom-in tool" button on the Zooming and Scrolling toolbar. 66
Ctrl-M	Marquee zoom tool. Click on the waveform and drag to draw a box (a marquee), and PicoScope will zoom in to make the box fill the view. Equivalent to the "Marquee zoom tool" button on the Zooming and Scrolling toolbar. 66
Ctrl-O	Zoom-out tool. Click on the waveform to zoom out. Equivalent to the "Zoom-out tool" button on the Zooming and Scrolling toolbar. 66
Ctrl-S or Esc	Cancels a zoom or pan mode and restores the pointer to a standard selection tool. Equivalent to the "Normal selection tool" button on the Zooming and Scrolling toolbar. 66
Ctrl-U	Zoom to 100% scale. Restores a view to its normal state. Equivalent to the "Zoom to 100% scale" button on the Zooming and Scrolling toolbar. 66
Space bar	Starts and stops the scope device.

9.6 Glossary

AC coupling. In this mode, the scope device rejects very low signal frequencies below a few hertz. This allows you to use the full resolution of the scope to measure a.c. signals accurately, ignoring any d.c. offset. You cannot measure the signal level with respect to ground in this mode.

AWG. An arbitrary waveform generator (AWG) is a circuit that can generate a waveform of almost any shape. It is programmed with a data file, supplied by the user, which defines the output voltage at a number of equally spaced points in time. The circuit uses this data to reconstruct the waveform with a specified amplitude and frequency.

Channel. A scope device has one or more channels, each of which can sample one signal. High-speed scope devices typically have one BNC connector per channel.

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DC coupling. In this mode, the scope device measures the signal level relative to signal ground. This shows maximum information about the signal, including d.c. and a.c. components.

ETS. Equivalent Time Sampling. A method of increasing the effective sampling rate of the scope by processing multiple captures in software. In a scope view, the program captures several cycles of a repetitive signal, then combines the results to produce a single waveform with higher time-resolution than a single capture. For accurate results, the signal must be perfectly repetitive and the trigger must be stable.

Graticule. The pattern of broken grey lines in every view. These help you estimate the amplitude and time or frequency of features on the waveform.

Grid. The arrangement of viewports. The number of grid rows and the number of grid columns can each be either 1, 2, 3 or 4.

In focus. PicoScope can display several views, but one view is drawn in stronger colours than the others. This is the view that is in focus. When you click a toolbar button, it will usually affect only the view that is in focus. To bring a view into focus, click on it.

Probe. An accessory that attaches to your oscilloscope and picks up a signal to be measured. A probe can pick up any form of signal, but it always delivers a voltage signal to the oscilloscope. PicoScope knows about standard probes, but also allows you to define custom probes.

Roll mode. Normally, PicoScope redraws the waveform in a scope view many times every second. At timebases slower than 200 ms/div, however, it switches to roll mode. This causes the waveform to move continuously from right to left, with old data disappearing off the left-hand side and new data being added on the right-hand side. This mode is more convenient for viewing slowly changing data.

Ruler. A vertical or horizontal dashed line that can be dragged into place on a waveform in a scope view. PicoScope displays the signal level, time value or frequency value of all rulers in a Ruler Legend box.

Scope device. A box of electronics that, with the help of the PicoScope software, turns your computer into a PC Oscilloscope.

Tooltip. A label that appears when you move the mouse pointer over some parts of the PicoScope screen, such as buttons, controls and rulers.

Trigger. A device that detects when the waveform rises or falls past a preset signal level. When this event occurs, the program may begin to acquire data.

View. A presentation of data from a scope device. Views may be scope views or spectrum views.

Viewport. A rectangular space in the PicoScope window that can contain one or more views, or can be empty.

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